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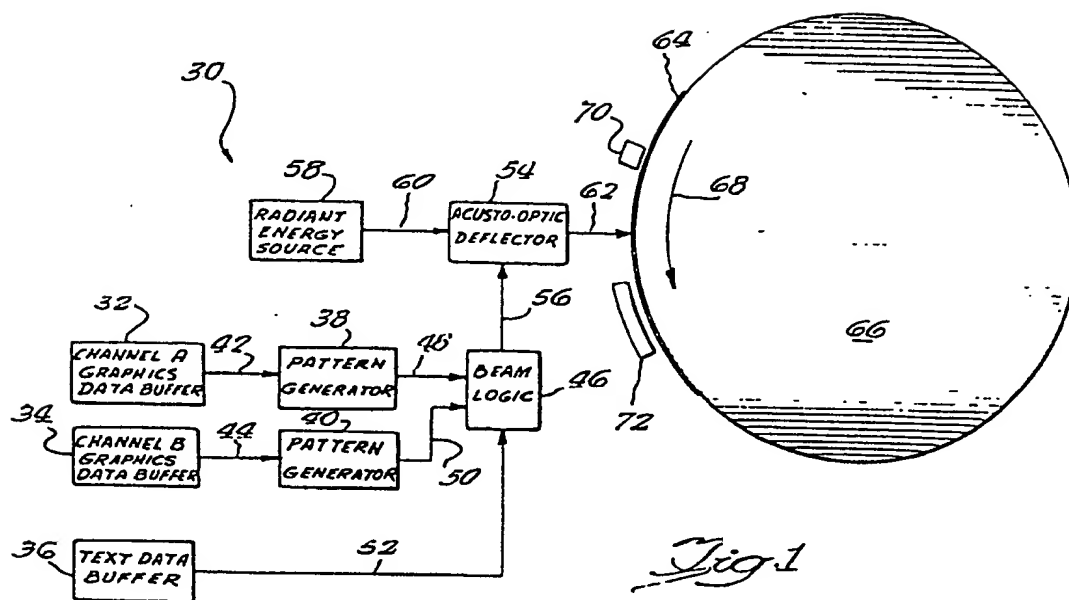
(54) Digital platemaker system and method.

(57) A digital plate maker system to receive graphics and text data and selectively discharge incremental areas of a charged electrophotographic member to form thereon the latent images represented by the graphics and text data, the imaged member thereafter being toned and output from the system. Thereafter, the toned image may be fused on the member and the member being used in an offset lithographic printing press. The digital platemaker system includes an optical system which may form a maximum of 22 individual rays which are direct deflected twice through a field flattening lens and then onto the charged member. The optical system further

includes an optical scale or grating which provides electrical signals indicating the precise location of the individual rays along scan lines on the member. The digital plate maker system further includes an electronic system which generates electrical signals to form the 22 individual rays. The text data is used to modulate signals produced by the graphics data, the result of the modulation being the beam control signals

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used to form the 22 individual rays. The digital plate maker system further includes a toning system which provides a vertical meniscus which is essentially stationary with the electrophotographic member as the electrophotographic member is rotated past the toning station.



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5 CROSS-REFERENCE TO RELATED APPLICATION AND PATENT

References made hereinafter to a co-pending application
Ser. No. 11,320 filed February 13, 1979 and entitled
"DIGITAL LASER PLATE MAKER AND METHOD", the applicant
10 being Lysle D. Cahill.

References also made hereinafter to a patent No. 4,025,339
issued on May 24, 1979 to Manfred R. Kuehnle.

15 Both the application and the patent above identified
are owned by the Assignee of the application herein.

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1 DIGITAL PLATE MAKER SYSTEM AND METHOD

The field of the invention comprises apparatus and a method for imaging electrophotographic members by means of radiant
5 energy devices such as lasers, the imaged electrophotographic members being thereafter used for printing. In the case of lithographic offset printing, the actual imaged member itself is treated to render toned and untoned parts hydrophobic and hydrophilic respectively and the member
10 comprises the plate without further processing. In other cases, the toned electrophotographic member may be used as an information source by reading the images or projecting them if transparent or photographically reproducing them if desired. The preferred use of the invention is to make the
15 printing plates upon metal such as stainless. Each of these substrates is coated with a type of photoconductive coating which will be described hereinbelow.

In the printing industry, printing plates for printing both
20 graphics and text have in the past been produced manually with the graphics images being reproduced using the so-called half tone process. In this process several photographic steps are used to reproduce the graphics image in an array of dots of varying size to reproduce the image on
25 the printing plate. Text information has in the past been hand set, but now may be set by machine under control of electronic devices.

Forming printing plates carrying both graphics and text images
30 ges may involve several steps, especially when color graphics are to be reproduced. In such a case, several color separation plates must be made for each color to be printed with the text information located on the plate in which color is to be printed. When text information is to be located
35 within the field of the graphics image, additional steps are required to form the solid printing areas for the plates in that particular color and to remove the graphics image from those same text areas on the remainder of

- 1 color separation plates. This of course adds to the
number of processed steps required to produce the de-
sired graphics and text images. The steps of forming the
graphics image to be printed in the graphics field is
5 commonly known as overburning while the process of re-
moving the graphics image from those same text areas
in the other color separation plates to be printed is
referred to or is commonly known as stripping.
- 10 In overburning, the negatives which form the graphics
image and the text image to be formed in that field are
overlayed one on another to form the desired color se-
paration printing plate. In stripping, other techniques
must be used to remove the graphics information from
15 those same text image areas.

The process of forming printing plates containing both
graphics and text data recently has been effected using
essentially the same methods as were performed manually.
20 Advanced systems however are able to compile from various
input devices data which may be used to form both
graphics and text information on a printing plate. But
these systems have their drawbacks in that separate
scanning cycles must be performed to form the graphics
25 and text images on a single printing plate and in
addition, complex switching circuits must be constructed
to switch between text and graphics image formation
when text images are to be formed within the field of
a graphics image.

30 The apparatus and method of the present invention over-
come these drawbacks presented by the manual and elec-
tronics systems by providing a system which in one pass
of a beam of radiant energy may form both graphics and
35 text images in response to graphics and text data input
thereto. Formation of the graphics and text images may
occur independently of one another so that different
imaging schemes may be used to form scaled densities

1 of the graphics images and the binary densities of the
text images.

Formatting of the data is such that the graphics data
5 contains information related to the relative scale
densities of incremental areas of the graphics image
with the remainder of the graphics data being a nullity
to clear the surface of a charged electrophotographic
member. The text data is formatted such that it does
10 not affect the formation of the images carried by the
graphics data except in locations where text images are
to be formed.

Formation of text images within the field of graphics
15 images for several different color separation plates
is performed simply by reversing the logical sense of
a control bit of every text data digital word. Thus to
produce text images of one color such as blue a multi-
color printed graphics image, the same data may be used
20 for all of the color separation plates with the control
bit for the color separation plate used to print the
color blue set to one logical state and being set to the
other logical state for the remainder of the separation
plates.

25 Thus the apparatus and method of the invention provide
for imaging of an entire printing plate with graphics
and text information in a single pass of a beam of
radiant energy.

30 The apparatus and method of the invention include an
optical system in which a beam of radiant energy from
a monochromatic source such as a laser is used selecti-
vely discharge and leave charged incremental areas of
35 a charged electrophotographic member. Part of the beam
is split and used as a reference beam. The remainder of
the beam is modulated to provide a scanning beam or a
fine beam comprised of individual rays of radiant energy

1 with each ray able to discharge an incremental of the
member. The reference beam and scanning beam or fine
beam are aligned vertically with one another with the
vertical alignment being used in an optical grating
5 system to precisely determine the location of the scan-
ning beam along the surface of the member. A field
flattening lens is used in which both the reference
and fine beams passed therethrough and back again to
the member, the field flattening lens providing the main-
10 tenance of a focused image on the surface of the member
across every scan line.

A common technique to determine the instantaneous position
of the scanning beam along a scan line of the member is
15 to employ an optical scale or grating composed of alter-
nate bars or space of opaque and transparent or reflec-
ting surfaces or areas. These alternating spaces occur
at intervals equal to the spacing between elements on
the member to provide electrical signals indicating the
20 alignment of the scanning beam with the elements. Light
passing through or being reflected from such a grating
is detected with a photosensitive device which converts
the energy into electrical pulses.

25 Over relatively short scan widths, by 10" or so, the
problem of accurately gathering or collecting light
pulses from an optical scale and directing them to the
photosensor is readily accomplished with relatively
simple optics. In much greater scan widths however the
30 cost of collecting optics rises exponentially and quickly
reaches prohibitive levels. The acting apparatus of the
invention herein has an active scan length of 24". The
cost of conventional optics for collecting a reference
beam across such a length and establishing a beam
35 feed-back within 1/300" accuracy is prohibited.

The concept of using a glass rod or fiber in such a
grating collection system is known. The principle used

- 1 to eliminate the fiber along its cylindrical surface to
collect the intercepted energy and detect the inter-
cepted energy as it exits the rod at either end thereof.
Original results with a short piece 3/8 inch diameter
5 glass provided poor results, it being believed that most
of the energy was transmitted through the diameter of
the rod so that the light output at either end of the
rod was too low to be of use.
- 10 The concept of using a hollow metal tube with a high
reflective interior surface to include transmissive
losses also was investigated. The tube used had a very
narrow length-wise slit to prevent entrance of the
radiant energy reference beam, and a photosensor was
15 mounted at one end with a mirrot located at the other
to reinforce the refected energy levels. It was believed
that the reference beam would strike the rear internal
surface of the tube and give rise to multiple reflections
which would propagate along the tube and result in a
20 useful output level at the end mounted sensor. The
optical surface smoothness on the interior was difficult
to control and in turn satisfactory reflections and
distributions were not obtained. At a consequencey there-
of, signal levels obtained from the hollow metal tube
25 vary greatly as a function of the beam position from
the sensor along the scan length. Automatic gain and com-
pensation techniques were implemented to modulate the
electronic signal from the sensor, but none of these
proved successful. In reevaluating the glass fiber
30 technique, it was believed that if the transmissive
losses of energy could be prevented by containing the
light within the fiber as within the hollow tube, the
rod collecting scheme might succeed.
- 35 A 1 3/4 inch rod was used because the internal diameter
of the existing hollow tube was about 2 inches and this
would faciliate concentric mounting of the rod within
the tube, and would further minimize further energy

1 losses by decreasing the concentric area. Essentially
the glass fiber rod was mounted within the length of
the tube. Initial tests met with little success until
a strip of masking tape was attached to the far side
5 of the rod opposite the beam entry point. Increased
energy level from the non-reflecting surface of the tape
was immediately recognized to be the result of eliminat-
tely the air-gap index of refraction (a high loss
component) while containing and reflecting the entrapped
10 energy. It was quickly determined that highly reflective
material such as a typewriter corrector fluid applied
to rod's cylindrical surface would be highly efficient
in preventing the transmissive loss and aid in providing
good Lambertian distributions. It was later determined
15 that it was not necessary to coat the entire surface
of the cylinder or rod. A narrow stripe of about 1/4
of an inch wide along the rod proved to be more than
adequate. Test results for rods of 0.78", 1.0", 1.5"
and 1.75" indicated that test results for the bar
20 collector used in the present invention would be ob-
tained with a bar diameter somewhere between 1.5" and
1.75".

Two prior art patents which disclose using a bar collec-
25 tor in an optical scanning or sensing apparatus are
U.S. Patents 4, 040,748 and 4,040,745. These patents
however do not appear to disclose the use of a bar
collector over the length required by the invention
herein.

30 The apparatus and method of the invention further
include an electronic system which performs the graphics
and text imaging process of the invention. As has been
explained, this method of the invention provides for
35 the intermixed formation of graphics and text images
on the electrophotographic member in one sweep or
pass of the imaging beam of radiant energy. To allow
formation of the graphics images with a processed

1 desired, the electronics provided are such that forma-
tion of the graphics and text images occur independently
of one another. That is to say, that unless there is text
image to be formed in a particular location on the
5 charged member, formation of the graphics image occurs
independently of the text.

Electrophotographic member used with the apparatus and
method of the invention allows the incremental areas
10 to be imaged which are finer than that presently avail-
able and allows those elements to be formed at a more
rapid rate and with less energy than as previously been
provided for. This electrophotographic coating will be
further referred to hereinafter.

15 The apparatus and method of the invention further in-
clude a toning system which applies minute toning par-
ticles to the areas of the latent image, which remain
charged. This toning system provides an essentially
20 vertical meniscus closely adjacent the plane at which
imaging of the member occurs so that there is a minimal
loss of voltage representing the latent image on the
electrophotographic member from imaging to toning.
Toning systems are known in which toning fluid is
25 applied to the bottom of a rotating drum carrying the
electrophotographic member wherein the distance from
the imaging to the toning is minimal. In the apparatus
of the present invention however a large drum is used
which rotates relatively slowly so that if a toning
30 system were used which is located at the bottom of the
drum, essentially all of the latent image would become
discharged by the time the member was rotated to the
toning station. Therefore, the toning station must be
located closely adjacent the plane in which imaging
35 occurs, which requires that toning fluid be applied in
a layer which is essentially vertical.

1 This vertical layer or meniscus is provided by used a
supply system or pressure system sealed to the atmos-
phere, allowing toning fluid to escape from the pressure
as the layer or meniscus of toning fluid and controlling
5 the rate of escape of the toning fluid by a valve ad-
mitting atmosphere to the otherwise sealed pressure
system so that the rate of flow of the toning fluid is
essentially equal to the movement of the member past the
toning station, and there is provided a vertical menis-
10 cus of toning fluid which is essentially stationary
relative to the member.

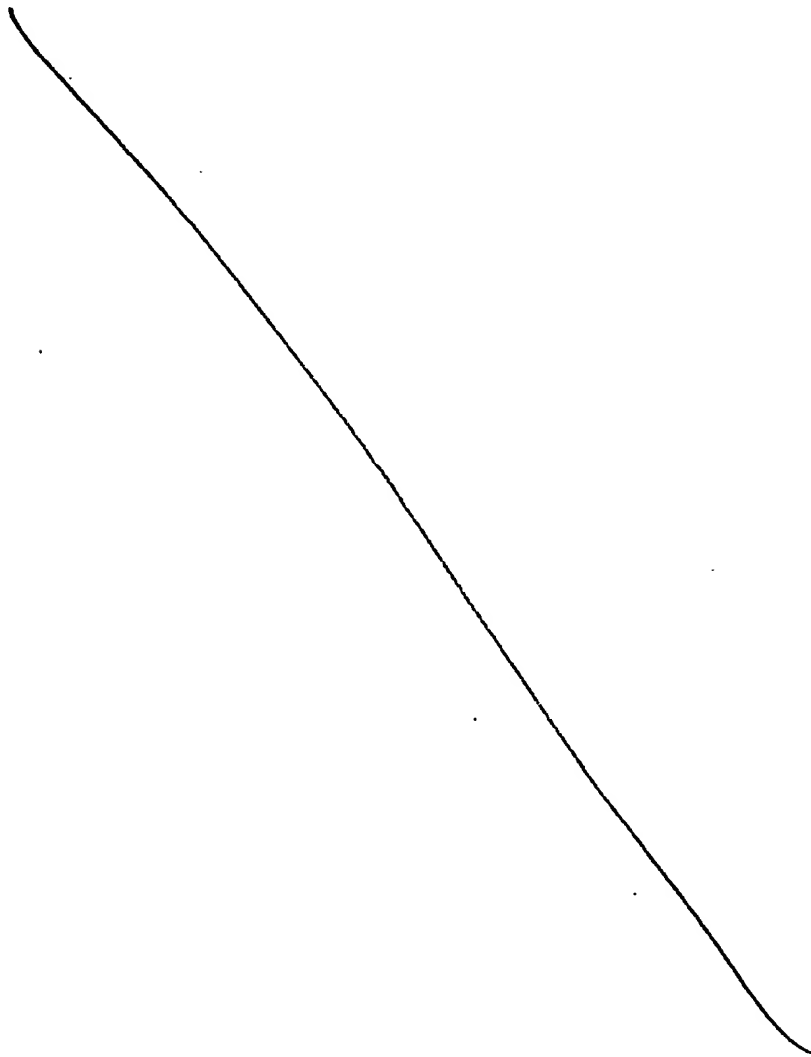
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1 SUMMARY OF THE INVENTION

A digital plate maker system and apparatus which receives binary digital graphics and text data to form
5 a toned latent image on electrophotographic member, the toned image thereafter being fused to the member and the member being used as a printing plate in an offset lithographic printing press. The plate maker system including an optical system, an electronics system and
10 a toning system.

The optical system providing 22 individual rays of radiant energy with which to discharge incremental areas of the electrophotographic member. The optical system
15 further providing field flattening to maintain a focused image of the individual rays across every scan line across the original image. An optical scale or grating system is provided which receives a reference beam of radiant energy vertically aligned with a fine beam which
20 may be comprised of the 22 individual rays, the bar collector receiving the reference beam across the length of every scan line. The bar collector directs the radiant energy from the reference beam to a sensor which provides electrical signals indicating the position of the
25 fine beam along the scan line.

A method of forming the text and graphics images on the member is implemented in electronic system. The graphic data is used to generate beam modulation signals to
30 form the desired number individual rays. The text data is used to modulate the beam modulation signals so that text images may be overlaid on graphic images or formed outside of fields of graphics images.

35 A toning system is used in the digital platemaker system to tone the latent images. The vertical meniscus, which as it flows is essentially stationary relative to the movement of the imaged electrophotographic member as it

1 passes a toning station.

5 BRIEF DESCRIPTION OF THE DRAWINGS

- Fig. 1 is a block diagram of an apparatus for making printing plates as constructed in accordance with the invention and uses the method of the invention;
- Fig. 2 is a left-side elevation of the apparatus;
- Fig. 3 is a plan view of the apparatus illustrated in Fig. 2 with the cover of the optical system and the cabinetry covering the drum removed;
- Fig. 4 is a schematic diagram of the left-hand optical system of the apparatus;
- Fig. 5 is a partial schematic diagram of the optical system illustrated in Fig. 4 taken along the lines 5-5 in the direction indicated;
- Fig. 6 is a partial schematic diagram of the optical system illustrated in Fig. 4 and taken along the lines 6-6 in the direction indicated;
- Fig. 7 is a partial schematic diagram of the optical system illustrated in Fig. 4 taken generally along the lines 7-7 in the direction shown;
- Fig. 8 is a representation of elements of a field flattening lens system;
- Fig. 9 is a schematic diagram of the optical scale or grating system illustrated in Fig. 4 taken generally along the line 9-9 in the direction shown;
- Fig.10 is a top view of the bar collector illustrated in Fig. 9;
- Fig.11 is a chart of a field of graphics image areas and text pixels which is used in the explanation of the invention;
- Fig.12 is a chart of a field of graphics pixels which is used in the explanation of the invention;

- 1 Fig. 13 is a chart of a field of text pixels overlaid
with four graphics pixels, which is used in the
explanation of the invention;
- Fig. 14 is a more detailed block diagram of the electro-
5 nics and optical system of the apparatus;
- Fig. 15 is a more detailed block diagram of the pattern
generators illustrated in Fig. 14
- Fig. 16 is a more detailed block diagram of the beam
logic circuit illustrated in Fig. 14;
- 10 Fig. 17 is a chart illustrating which groups of indivi-
dual rays are controlled by individual bits of
text data words which is used in the explanation
of the invention;
- Fig. 18 is a more detailed block diagram of the multi-
15 plex and gating circuits of Fig. 16;
- Fig. 19 is a block diagram of the toning system of the
apparatus;
- Fig. 20 is a perspective view of the toning station and
drum;
- 20 Fig. 21 is a perspective view of a shoe used in the
toning system illustrated in Fig. 19;
- Fig. 22 is a sectional view of a charging station and is
a sectional view of the shoe illustrated in Fig.
21 showing the relationship of the charging
25 station and shoe to the drum, and
- Fig. 23 is an exploded view of a portion of the inter-
face between the drum and the shoe illustrating
the relative positions of the electrophoto-
30 graphic member and the toning fluid.

1 DESCRIPTION OF THE PREFERRED EMBODIMENT

In the preferred embodiment, the imaging device receives digital data representing the graphics and text images
5 to be printed or otherwise reproduced. This digital data is received from a compiling system which obtains raw data from such as optical scanning system, text input stations, etc., and compiles or formats the data representing the graphics and text materials into a form
10 which may be used by the imaging device of the invention herein. The data received by the imaging device also may be generated or synthesized by a computer or by other means and may be presented to the imaging device from a memory in which it has been stored or it may be presented
15 on line as it is generated or synthesized if the generation or synthesization rate is equal to or less than the imaging rate of an imaging device herein.

The output of the imaging device herein is an electrophotographic member carrying a toned latent image of
20 charged and discharged incremental areas formed in response to the digital data. The toned member thereafter may be fused and processed for use as a printing plate in an offset lithographic printing press with the
25 toned areas carrying ink to a receptor to form the tonal graphics and text images. If color printing is desired, as many electrophotographic members carrying toned latent images are formed, as there are colors which are desired to be printed, one member carrying a toned
30 latent image for each of what is commonly known as a color separation.

The imaging device or imager used in the preferred embodiment of this invention uses a laser beam to image
35 an electrophotographic member that includes a photoconductive coating that previously has been charged. The member is carried on a rotary drum, is toned on the drum and thereafter may be used to transfer the toned

1 image or to serve as a medium for projection or
printing of the image. In the case of printing, the
toned image is used to carry ink in a printing press,
the member having been treated to achieve hydrophilic
5 and hydrophobic areas to enable offset lithographic use
of member as a printing plate.

The preferred use of the imaged member herein is as a
printing plate and has the same type of photoconductive
10 imagable coating is preferably the receptor of the laser
beams which comprise the output from the apparatus of the
invention. Such coating is that which is described and
claimed in U.S. Patent 4,025,339.

15 The apparatus and method of the invention may best be
understood by considering that the binary digital data
input to the apparatus is used to binarily modulate a
beam of radiant energy from a laser to selectively dis-
charge and leave charged incremental areas of a charged
20 electrophotographic member. Thereafter, the selectively
charged and discharged pattern or image carried on the
member is toned and output from the apparatus.

The electrophotographic member is carried on the outer
25 circumference of a drum which is rotated along its long-
itudinal axis. Charging, imaging and toning of the member
on the drum occurs sequentially at adjacent stations as
the member is moved past the stations by the rotating
drum. Charging of the electrophotographic member may
30 be of any means desired and in the preferred embodiment
occurs by placing adjacent the outer circumference of the
drum a wire having a high voltage applied thereto. Toning
of the imaged member occurs by applying to the member a
quantity of carrier fluid obtaining toner particles. The
35 charging and toning occurring at stations respectively
above and below an imaging plane. Imaging of the charged
electrophotographic member occurs by passing a fine beam
of radiant energy from a laser across the surface of the

1 member in image lines which are parallel to the longitu-
dinal axis of the drum and lie in the imaging plane. Im-
aging of the entire surface of the charged member occurs
in sequential image lines as the member is moved by the
5 drum past the imaging plane.

The digital input to the imaging apparatus is in the
form of two channels of graphics data and one channel of
text data. Each digital word of the graphics data is used
10 to form a picture element or a graphics pixel on the elec-
trophotographic member. Every imaging line is comprised
of two scan lines of graphics pixels with each channel
of graphic's data respectively controlling the forming
of graphics pixels in one scan line.

15 The text data controls the formation of text pixels
across the entire scan line and therefore only one chan-
nel of text data is required. Every word of the text data
is comprised of 8-bits of information with the least sig-
20 nificant six bits each controlling the binary density of
a text pixel, the next least significant bit serving as
a control bit, and the most significant bit not being
used.

25 The graphics data and text data are formatted such that
they may individually form respective graphics or text
images across the entire area of the electrophotographic
member. The electronics of the invention herein uses both
text and graphics data to form one channel of laser modu-
30 lation signals. Further, in the imaging apparatus herein,
the information carried by the text data is used to gate
the formation of the individual rays of the fine beam of
radiant energy, each of which rays are used to discharge
an incremental area on the charged electrophotographic
35 member. Simply stated, it may be thought of that the text
data is used to gate or modulate the formation of graphics
pixels in response to the graphic data. Thus if the text
data is a nullity, no text images are to be formed on the

1 member, the information carried by the graphics data will form the graphic image represented thereby and discharge the remainder of the member.

5 Where the text data contains information representing a text image to be formed on the member, the text data may either inhibitit the formation of individual rays of the fine beam or depending on the logical state of the control bit included in each word of text data. When

10 the text data inhibits the formation of individual rays of the fine beam, the text image is formed on the member which will be toned and in the printing plate will carry ink to the receptor to print a solid image. This is a case where black text is desired on any background. When

15 the text data forms individual rays of the fine beam, text pixels are discharged on the member with the discharged areas of the member forming areas of the printing plate which do not print on the receptor or which remain clear. This is the case where clear text is desired with-

20 in a graphics image. Within the preferred embodiment of the invention, the text pixels are nine times more numerous than the graphics pixels, i.e., for every graphics pixel, there are nine text pixels which may be discharged or left charged. The resolution provided by the text

25 pixels is not however nine times the resolution provided by the graphics pixels because of overlap of the text pixels. Of course it will be understood that the electro-photographic member is not physically divided into pixels of any type, scan lines or image lines, and that these

30 terms are used only to describe the operation of the imaging apparatus and method.

Referring now to Fig. 1 of the drawings, the apparatus of the invention there is illustrated diagrammatically

35 is indicated generally by the reference character 30. Two channels of graphics data are received by the apparatus respectively on channel A and channel B graphics data buffers 32 and 34. Text data is received

1 into text data buffer 36. The graphics data contained
in data buffers 32 and 34 individually are applied to
pattern generators 38 and 40 over leads 42 and 44. In
5 pattern generators 38 and 40, the density information
carried by the digital words of the graphics data are
converted into patterns of elements which are to be
formed in graphics pixels on the member, the pixel
patterns representing the densities indicated by the
10 graphics data. The pattern information produced by pat-
tern generators 38 and 40 then is applied to modulator
46 on leads 48 and 50 together with the text data from
text data buffer 36 on lead 52. In modulator 46, the
text data is used to modulate the pattern information
15 from pattern generators 38 and 40. The output of modula-
tor 46 which is applied to acousto-optic modulator 54
is the ray data which controls the formation of indivi-
dual rays in the fine beam. The output of modulator 46
is carried to the acousto-optic modulator 54 on lead 56.
A radiant energy source 58 is provided which produces a
20 beam of radiant energy 60 which essentially at one wave
length and which is directed to acousto-optic modulator
54. Radiant energy source 58 is in the preferred embodi-
ment a laser with the wave length of the beam of radiant
energy 60 being chosen to most advantageously discharge
25 area of the electrophotographic member. Acousto-optic
modulator 54 modulates the beam of radiant energy 60
to provide a fine beam 62 of radiant energy comprised
of a plurality of individual rays and in some cases
as little as a single ray.

30

The fine beam 62 is directed onto an electrophotographic
member 64 carried on a drum 66 rotating in the direction
indicated by arrow 68. The thickness of member 64 is
exaggerated in Fig. 1 only so that member 64 may easily
35 be seen on the circumference of drum 66. Charging of
member 64 occurs at charging station 70 prior to the
time at which fine beam 62 is applied to member 64 and
toning of member 64 occurs after imaging by fine beam 62

1 at station 72.

It should be pointed out that while the preferred purpose of the invention is to make offset lithographic plates by electrostatic techniques described herein, any
5 use of an electrophotographic member will find advantages where a member has been imaged according to the invention.

10 It will be appreciated that in forming several different color separation plates, it may be desired to form text images of a single color (for example blue text) in a field of a graphic image or otherwise. Thus in the blue printing separation plate, the text image must be found
15 solid. On the other color separation plates that same area must be cleared so that only the color blue will be printed therein or the recepta. Thus by selectively using the solid forming and clearing capabilities of the text data, one may form the solid printing blue text
20 image in the field of graphics or otherwise as may be desired.

Turning now to Fig. 2 and 3, the preferred embodiment of the digital plate maker is illustrated including some
25 of the cabinetry provided therewith. The apparatus 30 includes an optical cabinet 80 which encloses a left-hand optical system 82 and a right-hand optical system 84. Drum 66 extends the width of the left-hand and right-hand optical systems 82 and 84 so that an electro-
30 photographic member carried thereon may be simultaneously and separately imaged by respective optical systems. Drum 66 is supported at each end by supports 86 and 88 and is rotationally driven by motor 90. As shown in Fig. 2, the drum is enclosed by a housing 92, which protects a
35 member carried on drum 66 from ambient light. Optical cabinet 80 and housing 92 adjoin each other there being only a small slit opening between them through which the fine beam passes on its way to the charged electrophoto-

1 graphic member.

The electrophotographic member is held on drum 66 by a magnetic chuck which is formed of magnetic strips extending the length of drum 66 at the circumference thereof. The magnetic field produced by these magnetic strips is strong enough so that an electrophotographic member having a substrate of such as stainless steel will be securely held on the drum. In the preferred embodiment, the drum circumference is 1250mm. while the drum length is 1,100mm. The drum is continuously rotated at a speed of 0.125RPM which corresponds to 180 revolutions per day or 8 minutes per revolution. This provides a drum speed of 2.6mm per second.

15 The center line of the charging station 70 is arranged to be 25 degrees above the image plane, while the center line of the toning station 72 is arranged to be 30 degrees below the imaging plane.

20 The maximum size electrophotographic member which may be carried by the drum 66 is a member which is 1.040 by 1.040 mm and the area of the member which may be imaged by each of the left and right hand optical systems is 50 cm. axial of the drum by 70 cm. circumferential of the drum or an area which is 20 x 28 inches.

A cabinet is provided in which the toning tanks and pumps are contained with the hydraulic and nomadic connections between cabinet 94 and toning station 72 (not shown in the drawings for clarity purposes). Mounted on the exterior of cabinet 80 are two lasers 96 and 98, which provide the radiant energy respectively to the left-hand and right-hand optical systems 82 and 84. The entire apparatus 30 is supported by a frame 100 having the general configuration of a table. Auxillary equipment for operating the apparatus 30 such as power supplies for the lasers 96 and 98 serve or

1 control electronics for the motor 90 and auxillary tanks
for the toning system may be mounted under frame 100,
and are not shown in Fig. 2 for clarity of the drawing.

5 As may be seen in Fig. 3, the left-hand and right-hand
optical systems 82 and 84, are mirror images of one
another so that a description of one is a description
of the other. Referring also to Figs. 4, 5, 6 and 7,
lazer 96 provided the beam of radiant energy 60 to
10 special filter 110 which provides what may be termed a
pinhole aperture to obtain a desired cross-sectional
size of the beam. The beam 60 is transmitted through
special filter 110 to folding mirror 112 which deflects
beam 60 to beam splitter 114. A portion of beam 60 is
15 transmitted through beam splitter 114 and forms a refe-
rence beam 118 which is deflected by folding mirror 120
and 122 to a spot forming lens 124. The portion of beam
60 which is deflected by beam splitter 114 is directed to
acousto-optic deflector 54 which forms of beam 60 the
20 individual rays which have been refered to as the fine
beam 62. Fine beam 62 exits acousto-optic deflector 54
and passes through spot forming lens 126 and passes
under folding mirror 128. Reference beam 118 passes
through spot forming lens 124 as deflected by folding
25 mirror 128. After fine beam 62 passes under folding
mirror 128, fine beam 62 and reference beam 118 are
vertically aligned with one another through the remainder
of the optical path. Referring to Fig. 5, reference beam
118 which is transmitted through beam splitter 114 is re-
30 presented by a crossed line indicating the light in refe-
rence beam 118 is exiting the drawing figure. Folding mir-
ror 128 also is shown in Fig.5 located above fine beam 62
after it passes through spot forming lens 126 and the
circle at the center of folding mirror 128 representing
35 that reference beam 118 is directed into drawing Fig. 5.
Fine beam 62 and reference beam 118 then are deflected
by folding mirror 130 with the crossed lines in Fig. 5
on folding mirror 130 indicating the light is exiting

1 from the drawing figure while the circles on folding mirror 130 on Fig. 6 indicate that the light is entering the drawing figure.

5 Fine beam 62 and reference beam 118 then are passed through a relay lens 132 to a folding mirror 134. Again the crossed lines on folding mirror 134 on Fig. 6 representing that the beams are exiting the drawing figure. As also is shown in Fig. 7, beams 62 and 118 are de-
10 flected by folding mirror 134 through an $f \theta$ lens system 136 to a galvanometer mirror 138. Galvanometer mirror 138 is rotatably oscillated in the directions indicated by arrow 142 and directs fine beam 62 back through the $f \theta$ lens system 136 through an aperture 144 extending
15 through the front plate 146 of cabinet 80 and then onto the charged electrophotographic member 64. Reference beam 118 is deflected by galvanometer mirror 138 back through $f \theta$ lens system 136 and onto a folding mirror 148 to an optical scale or grating system 150.

20 It will be noted that the deflection of fine beam 62 and reference beam 118 in horizontal directions by galvanometer mirror 138 does not disturb the vertical alignment of these two beams so that the position of
25 reference beam 118 may be sensed by the optical scale or grating system and precisely locate the position of fine beam 62 which is used to image or write the images on the electrophotographic member 64. Galvano-
30 meter mirror 138 deflects fine beam 62 through a scan line 152 illustrated in Fig. 6 and deflects reference beam 118 along a scan line 154 lying on deflecting mirror 148. The extent to which the galvanometer mirror deflects fine beam 62 and reference beam 118 are represented in Fig. 4 by dashed lines 156.

35 It will be noted that as illustrated in Figs. 6 and 7, fine beam 62 and reference beam 118 are located below the imaging plane defined by fine beam 62 as it passes

1 through aperture 144 and is directed onto electrophoto-
graphic member 64. The $f \theta$ lens system 136 provides field
flattening for both fine beam 62 and reference beam 118
so that they may be maintained in focus respectively
5 across the surface of the electrophotographic member and
across the surface of the optical scale or grating system
150. It will be noted that the distance travelled by fine
beam 62 along an optical path from spot focusing lens 126
to member 64 is equal to the distance travelled along the
10 optical path by reference beam 118 from spot forming lens
124 to optical scale or grating system 150.

The spacial filter or folding mirrors, beam splitters,
spot forming lenses, relay lens and galvanometer mirror
15 are all common optical elements which readily may be
constructed and arranged in a system as has been des-
cribed as may be desired.

In the preferred embodiment this spot forming lenses
20 have a focal length of 26 mm, the relay lens has a focal
length of 200 mm and the $F \theta$ system has a focal length
of 870 mm. The distance between the spot forming lens
and the relay lens is 559.2 mm while the distance bet-
ween the relay lens and the $F \theta$ lens is 1,190 mm. The
25 distance from the $F \theta$ system to the focal plane at the
electrophotographic member 64 and the optical scale
system 150 is of course 870 mm.

The $f \theta$ lens system 136 is illustrated in Fig. 8 and
30 comprises elements L1 through L4 having surfaces de-
fined by radii R1 through R8 as shown.

The lens of Fig. 8 comprises from the object end a
first positive group L1, L2 having a concave object
35 side surface; a second positive group L3 having a flat
object side surface; and a third positive group L4
having a flat object side surface and a convex image
side surface.

- 1 The lens of Fig. 8 is defined substantially by the data of Table I, as scaled to a focal length of 870 mm;

	<u>LENS</u>	<u>Radius</u>	<u>Axial Distance Between Surfaces (mm)</u>	<u>N</u> <u>d</u>	<u>V</u> <u>d</u>
5	R1	- 161.744			
	L1		15.00	1.617	36.6
	R2	00			
	R3	-216.311	6.97		
10	L2		28.871	1.523	58.6
	R4	-213.119			
			0.20		
	R5	-2575.204			
	L3		18.06	1.523	58.6
15	R6	-264.288			
			0.20		
	R7	00			
	L4		13.00	1.523	58.6
	R8	-265.847			

20

The lens disclosed may of course be scaled otherwise as is desired.

- 25 The acousto-optic deflector 54 is capable of separating beam 60 into as many as 22 individual rays or beamlets which form fine beam 62. In the preferred embodiment as many as 22 individual radio frequency signals may be applied to acousto-optic deflector 54 to deflect the 22 individual rays each radio frequency signal being capable of deflecting one individual ray. Acousto-optical de-
- 30 flector 54 is constructed and arranged so that the individual rays which are deflected from beam 60 are aligned vertically in fine beam 62 and so that in the focused images formed on the electrophotographic member 64 are arranged adjacent and spaced equidistant from one another. Thus a radio frequency signal of the first frequency will form one individual ray while the next radial frequency signal will form an adjacent ray and so on.
- 35

- 1 In the preferred embodiment acousto-optic deflector 54
is capable of deflecting 22 individual rays and although
deflector 54 operates on the principle of acoustically
deflecting the individual rays other deflection apparatus
5 may be used in place of.

The optical scale or grating system 150 comprises a
grating 160, a bar collector 162 carrying a narrow
stripe of reflective material 164 on the outer surface
10 thereof and a sensor 166 such as a photomultiplier tube.
As is illustrated in the drawing figures 9 and 10 the
optical scale or grating system extends the entire
length of the scan lines across which fine beam 62 and
reference beam 118 are deflected. In turn grating 160
15 and bar collector 162 extend over this length of the
scan lines across which the beams may be deflected.

Grating 160 is an elongate transparent member carrying
alternating opaque and transparent lines or spaces
20 having a frequency related to the frequency of the rows
in an imaging line. Grating 160 is arranged so that
reference beam 118 is deflected across the opaque or
transparent areas or lines on every imaging line.

25 Bar collector 162 is an elongate cylindrical member which
extends the length of grating 160 and is arranged relative
to grating 160 so that when reference beam 118 passes
through grating 160, reference beam 118 passes through
the diameter of bar collector 162 to strike transparent
30 material 164. When reference beam 118 strikes reflective
material 164, a lambertian distribution of the scattering
of reflective light occurs in the bar collector 162 and
the light so entering bar collector 162 remains therein
and is transmitted to the end of bar collector 162 where
35 it is sensed by sensor 166. As shown in Fig. 10, the end
of bar collector 162 opposite sensor 166 carries a
mirror thereon or is a mirrored surface to reflect light
along the length of the collector to the sensor 166.

- 1 Sensor 166 provides an analog electrical signal on leads
170 which indicate reference beam 118 entering the bar
collector 162.
- 5 In the preferred embodiment bar collector 162 has a
diameter of 1.75 inches and is made of such as acrylic
materials although material known under the trademark
of lucite has provided good results. The narrow stripe
of reflective material 164 may be any highly reflective
10 material and in the preferred embodiment a typewriter
correction fluid is used. The length of the bar collec-
tor 162 is about 24 inches to provide the desired 20
inch imaging line plus sufficient length for housekeeping
and related needs.
- 15 In evaluating the glass fiber technique used herein for
the bar collector 162 it was discovered by placing a
strip of masking tape along the length of bar collector
162 opposite the point of entry of reference beam 118
20 that a significant increase in the energy transmitted
by bar collector 162 was obtained. The increased energy
level from the nonreflecting surface of the tape was
immediately recognized to be the result of eliminating
twice the area-gap index of refraction (a high loss
25 component) while containing and reflecting the trapped
energy beam. It was quickly determined that a highly
reflective material such as typewriter correction fluid
applied to the rod's cylindrical surface would be
highly efficient in preventing the transmissive loss
30 and aid in providing good lambertion distribution of
reference beam 118 striking the same. Further investi-
gations showed that it was necessary to coat only a
stripe about 1/4 of an inch wide along the length of
the rod provide more than adequate energy for the sensor
35 166. Best results for 24 inches long rods indicated that
the best energy response was obtained by using a rod
diameter of from 1.5 inches to 1.75 inches.

1 In the preferred embodiment the grating 160 has a three
hundred line per inch optical scale to provide the
signals from sensor 166 to locate the position of fine
beam 60 along electrophotographic member 64.

5

It should be noted that it is important that the sensor
166 not look at the entire cross-section of the end of
the collector tube 162, but only at a smaller area
centered around the longitudinal axis of a bar collector
10 162. It also is important that only the single narrow
stripe of reflective material 164 is on the circumference
of the bar and the remainder of the circumference of the
bar is otherwise clean to maximize the internal reflec-
tion of light on the bar. The leads 170 from the sensor
15 166 in the preferred embodiment are connected to an auto-
matic gain control amplifier to smooth out the signal from
the bar collector 162 in response to beam 118 entering
the collector at different distances from the sensor. In
the preferred embodiment the signal from the automatic
20 amplifier is used in a phase locked loop to provide the
desired signals indicating the location of a fine beam
62 along the imaging lines on the member 64.

It is important that the reference beam 118 present a
25 focused image across the entire length of grating 160
so that the signals provided from sensor 166 will be
well defined. If reference beam presents focused images
which are off the plane of grating 160, the edges of
the pulses generated from sensor 166 will not be well
30 defined and the location of fine beam 62 along the
imaging lines will not be precise.

As has been stated digital data which is input to
the digital platemaker is in the form of graphics data
35 and text data. The graphics data is used to reproduce
graphic images on the electrophotographic member 64
with one black and white image or one color separation
image being formed on each member.

1

The graphics data is in the form binary digital words with the value of each word representing a scaled areal density to be formed on an imaging area on the member. Each word is used to select a pattern of elements from a memory or other storage device which represents the scaled density equal to the value of the graphics digital word.

10

The patterns selected from the memory are formed on the member by discharging and leaving charged elements in an imaging area. The elements are arranged equispaced across the surface of the member and are arranged in rows and columns. Selective elements in the imaging areas are used to form the patterns and in the preferred embodiment are grouped together in irregular hexagonal picture elements or pixels. It should be remembered that the configuration of the pixels is a choice of the designer the imaging areas in which the configurations may be formed being of a predetermined number of rows and of a predetermined number of columns. One pattern then may be formed in one pixel.

25 The columns at which the elements are located are defined by the lines which would be formed by the individual rays or beamlets of the fine beam 62 as they are passed across an imaging line. The rows of the imaging lines are defined by sample clock signals produced from the grating system 150.

35 The imaging lines are comprised of two scan lines of graphics pixels with each scan line of graphics pixels being controlled by one graphics data channel. Thus graphics channel A controls the graphics pixels to be formed in scan line A, and the graphics data in channel B controls the graphics pixels to be formed in scan line B.

1

It bears repeating that if the text data contains no information to be formed on the electrophotographic member 64, the graphics data is formatted so that the graphics image or images contained therein will be formed on the member 64 while the remainder of the surface of light 64 will be discharged. Thus the printing plate formed by such graphics and text data will print on the receptor only the graphics image or images and leave a clear background.

The text data is used to reproduce text images and line graphics such as charts and graphs on member 64. While the graphics data provides for the scale density of the imaging areas to be formed on member 64, the text data is used to provide binary imaging of image areas of the member 64 which in the preferred embodiment are the same as text pixels.

20

In the preferred embodiment the text pixels have a definite relationship to the graphics pixels.

In every imaging line the text pixels are aligned six abreast with the text pixels being two rows wide. Specifically, what may be called the first text pixel or scan line covers the area defined by the first four columns of individual rays by two rows deep. The next text pixel is three columns wide by the same two rows deep. The next two text pixels are each four columns wide and the same two rows deep. The next text pixel is three columns wide and the same two rows deep, and the last text pixel is four columns wide by the same two rows deep. Thus it may be said that the text pixels are arranged across the imaging line at every two rows. Every word of the text data represents the binary imaging to be formed in text pixels formed along the same two rows of the image line. For each of the six

1 text pixels in those two rows, there are four possible
states of conditions. The first two states are defined
as being the normal states, the first of which will in-
hibit the formation of rays of fine beam 62 to be
5 charged areas of the member 62. These charged areas
will form solid printing which will print such as black
ink on a white background. The second condition is to
enable the formation of individual rays of fine beam 62
as determined by the graphics data for that row. The
10 last two states are defined as being the reverse mode,
the first condition of the reverse causes a formation
of rays of fine beam 62 to discharge areas of the member
64. These discharged areas will then form text images
in areas otherwise formed of graphics images to provide
15 printing plates which print clear text in graphics images.
The last state of the reverse mode enables the formation
of rays under control of the graphics data.

These four states are formed of the binary combination
20 of a control bit and one data bit of every word of the
text data. Thus as will be explained hereinafter, one
data bit and one control bit of every word controls in-
hibiting of the formation of rays, enabling of formation
of rays by the graphics data or causes the formation of
25 rays in every text pixel.

If the graphics data is a nullity and is used only to
clear the entire plate, then the information contained
in the text data will be able to form text images only
30 by inhibiting the formation of rays to leave charged
areas which will print solid on the receptor. This is
the first condition under the normal state. It will be
noted that text images will not be able to be formed
by the first condition of the reverse which causes the
35 formation of rays because the graphics data is clearing
the plate and there will be no background against which
to form the clear text images.

1 If the graphics data is full density for the entire
plate no rays will be formed anywhere across the plate
by the graphics data. In such a case, the only text
5 images which may be formed are under the reverse mode
first condition which causes the formation of the rays
to discharge areas in an undischarged field to print
clear in a field of solid printing area. It will be
noted that in such a case the first state or condition
10 of the normal mode has no effect to create or form a
text image by inhibiting the formation of rays because
there are no rays being formed by the graphics data.

Thus the relationship between the graphics and text
data may be described as one where the graphics data is
15 able to form graphics images across the entire imaging
area of the member 64 and depending upon the images
so formed the text data may form text images. Moreover,
the graphics data contains enough information to image
across the entire imaging area of member 64 as does
20 the text data with formation of patterns in the graphics
pixels and the formation of the text pixels being en-
tirely independent of one another. Imaging the graphics
then text in this matter has advantages in that diffe-
rent imaging schemes for the graphics may be implemen-
25 ted without interfering between the relationship between
the graphics and text imaging.

Referring now to drawing figures 11, 12 and 13, there
is illustrated in fig. 11 a chart of three imaging lines
30 which are formed on the electrophotoconductive member 64.
Imaging lines 1 and 2 illustrate the formation of
graphics pixels while image line 3 illustrates the
formation of text pixels. Image lines 1 and 2 each com-
prise an A-channel scan line and a B-channel scan line,
35 there being six thousand (6,000) image positions in
each of the A-channel and B-channel scan lines with the
imaging positions in the B-channel scan lines being
offset relative to the imaging positions in the A-channel

1 scan lines. Thus in each of image lines 1 and 2, there
are 6,000 graphic pixels which may be formed.

Referring now to Fig. 12, there is depicted a field of
5 graphics pixels which may be presumed to be laid out on
the surface of the electrophotographic member. The pixels
are irregular hexagonal areas designated GP1, GP2, GP3,
GP4 and GP5 inclusive and are parts of an overall pattern
of hexagons which cover the surface of member 64.
10 Obviously the defining lines illustrated in Figs. 11,
12 and 13 are imaginary and merely represent a theoretical
geometric pattern which for convenience describes
the manner in which the imaging is effected.

15 The individual rays of fine beam 62 are going to remove
charge from the graphics pixel respectively. The possi-
bility for removal is represented in this case by ele-
ments of discharge which are generally circular and
which count for the entire interior of each graphics
20 pixel. The graphics pixels according to the invention
are arranged in interleaved columns so that the field
of pixels may be considered to occupy all of the area.
Graphics pixels GP1, GP2 and GP3 are shown with their
flat sides respectively in common at 200 and 202 while
25 the flat sides of graphics pixels GP4 and GP5 are in
common at 204. The adjoining pixels to the left and to
the right of these pixels are also arranged in this
way but are not illustrated. The graphics pixels in
adjacent scan lines are interleaved or staggered relative
30 to one another; hence, pixels GP4 and GP5 have their
top apexes at the location of the common flat sides
200 and 202 as indicated for example at 206 and 208.
This interleaving is illustrated for adjoining scan
lines in fig. 11.

35

Graphics pixels GP1, GP2, GP4 and GP5 have centering
points laid out in them which are numbered and which
can be seen to be formed at the junctures of rows and

- 1 columns that are marked above and to the left of the
field of pixels. The columns are defined as imaginary
lines described by each of the individual rays of fine
beam 62 as fine beam 62 is swept across each image line.
5 The rows are defined along the image line by the opti-
cal grating system 150 and occur at equidistant inter-
vals along every image line.

In the preferred embodiment, the image positions illus-
10 trated in Fig. 11 are defined as having six rows numbe-
red 0-5 and 11 columns. Scan line A is formed of columns
1-11 while scan line B is formed of columns 12 through
22, the column numbers corresponding to the number of
individual rays. While the graphic pixels GP1 through
15 GP5 in the preferred embodiment have been defined as
irregular hexagons having the number of elements illus-
trated, the graphic pixels may be defined as having any
geometric configuration desired which fits the limita-
tions of the six rows and eleven columns. As will be
20 described more fully hereinafter concerning the electro-
nics, the limitations of six rows and eleven columns
is purely one of electronics such that by modifying
the electronics any number of the number of columns
and rows may be defined to be an imaged area and in turn
25 any geometric configuration desired may be formed there-
in.

In the preferred embodiment there are 19 centering points
for the elements in each graphics pixel and these are
30 arranged in fifteen horizontal columns and six vertical
rows. The columns are all confined within each graphics
pixel between its top and bottom apexes. All graphics
pixels are considered to be oriented exactly the same
with their long flat surfaces left and right and apexes
35 top and bottom. While the rows are formed somewhat dif-
ferently. Five of the rows will have centering points
that are within the confines of the graphics pixel bet-
ween left and right flat sides, while the sixth row image

1 will never have centering points located thereon is
coincident with the left and right flat sides of the
graphics pixels. This is a spacing expedient to be
explained later.

5 The centering points which have been described are the
centers of the circular dischargable or formable elements
such as 210 which are going to be discharged by the in-
dividual rays. As seen the circular element 210 which
10 is the same as all others is large enough so that in
addition to covering a certain area within its graphics
pixel overlaps into adjoining pixel. Thus the circular
element 88 not only discharges the area within the
graphics pixel GP3 which it encompasses but also has
15 a cordal slice or segment which it discharges at each
of graphics pixels GP6 and GP7 as indicated at 212 and
214.

If we drew a line between each of the centering points
20 vertically and diagonally, we would see the overall
patterns of general hexagonal area which can be seen
in the pixels GP1, GP2, GP4, GP5 and of course these
hexagons have the appearance that they are made up of
equilateral triangles. Thus the circular discharge ele-
25 ments such as 210 will discharge the area around its
centering point comprised of the six equilateral triangle
surrounding that centering point plus six more cordal
segments beyond that hexagon defined by those triangles.
And since every other circular element will also dis-
30 charge the photoconductive surface of the electrophoto-
graphic member in the same way, the discharged circular
elements which are side by side always overlap.

Graphics pixels GP3 has six of the top circular elements
35 shown in outline at 216 and there overlapped areas are
obvious. In addition, there can be seen the 8 overlapped
cordal segments of discharge area that protrude into
adjoining pixels including the pixels GP2 and GP7.

- 1 For explanatory purposes, the total discharged area of
any graphics pixel can be approximated by the triangles
which are included in the circular elements discharged.
The more circular elements of discharge in a given
5 graphics pixel equals the approximation because of the
overlap within the graphics pixel. In the circular
element 210 the equilateral triangles are identified as
TR1 to TR6 inclusive. It is illustrated in graphics
pixels GP1 and GP4 that in the horizontal columns there
10 is only one centering point in each of columns 1, 11, 12,
and 22; two centering points in each of columns 2,4,6,
8,10, 13, 15, 17, 19 and 21; and three points in each
of columns, 3, 5, 7, 9, 14, 16, 18 and 20. These con-
ditions are requirements of the electronics and may
15 be altered by altering the electronics as is desired.
In the preferred embodiment these conditions are
requirements of the electronics and must be met during
the laying down of the discharge elements.
- 20 The fine beam 62 which makes one pass to provide the
horizontal column information for generation of the
centering points for the graphics pixels which are
being described in an image line will be composed of
a maximum of 22 individual rays all passing over the
25 total image line at any one time. It is assumed that
all rays will be used for the graphics pixels in an
image line but the maximum number of rays or beamlets
that will be operating at any given time for the confi-
guration illustrated in Fig. 12 will be 9, because as
30 is illustrated in Fig. 12, there are no more than 9
centering points along any one row. This is shown in
Fig. 12 and graphics pixels GP2 and GP4 have scan
line A rows 0 and 1 and scan line B rows 4 and 5.
Along scan line A row 0 and scan line B row 4 centering
35 points 1, 2, 3 and 4 of graphics pixel 2 are defined
while centering points 16, 17, 18, 19 and 20 of graphics
pixel 4 are defined. Of course the minimum number of
rays or beamlets operating will be zero.

1

Summarizing then, the horizontal columns of centering points are controlled by the number of individual rays in a fine beam 62. The rows are controlled by the information that is obtained from the optical grating system 150. The row information is used in the beam modulation electronics to discharge the desired elements as will be described hereinafter. The patterns which are imaged in the graphics pixels in response to the density values indicated by the digital words of the graphics data may be of any configuration desired to represent the equivalent density and the preferred embodiment, there is one predetermined pattern which is to be formed in the graphics pixel for every density value indicated by the graphics data.

In the preferred embodiment the distance between the center lines of scan line A and scan line B is 169.3 microns while the distance between the flat sides of each graphics pixel is 171.7 microns. The diameter at each of the discharged elements is 35 microns with all of these values being based upon a 150 line per inch resolution.

25

It will be noted that as there are 24 individual elements in each graphics pixel which may be either charged or discharged there are a total of 2^{24} or approximately 16 million combinations of discharge elements which are available to image the desired density patterns. Thus, even if the graphics data may only represent 256 steps of density with 8 bits of information per graphics digital word, each step of the 256 step grade scale may be represented by a plurality of the 16 million available patterns which have density values equal to or approximately equal thereto.

The text pixels which are formed in response to the text

1 data are illustrated in figs. 11 and 13. As shown in
Fig. 11, the image line 3, there are six scan lines
of text pixels per image line. The text pixels are ar-
ranged 3 wide for every graphics data scan line and are
5 two rows deep. The arrangement of the text pixels re-
relative to the graphics pixels and the rows and columns
described hereinbefore is illustrated in figure 13.

The text pixels are arranged slightly shifted in relative
10 to the graphics pixels, and there are about 9 text
pixels per graphics pixels or graphics image area. Re-
ferring to fig. 11, along one image line there are
18,002 text pixel rows with six text pixels per row.
The 18,002 rows of text pixels results by multiplying
15 the 3,000 graphics pixel per scan line by 3 rows of text
pixels per graphics pixel plus two additional rows
of text pixels required to cover the area corresponding
to the channel B pixels which are shifted relative to
the channel A pixels.

20 The relationship of the text pixels to the graphics
pixels in the A channel scan line and B channel scan
line is illustrated in both figs. 11 and 13. The rela-
tionship of the text pixels to the columns defined by
25 the individual rays is illustrated in fig. 13.

Fig. 13 illustrates text pixels 1-48 arranged along
one image line and illustrates in dashed lines the
relationship thereto of graphics pixels GP1, GP2, GP4
30 and GP5. The electronics of the digital platemaker
system are arranged so that each word of the text data
received thereby operates on 1 text pixel row of six
abreast text pixels. Thus successive words of the text
data operate on the rows of text pixels TP1 - TP6,
35 TP7 - TP12 TP13 through TP14, and so on.

The text pixels are defined as being that area which
incloses a certain number of discharge elements which

1 are formable by certain rays of the fine beam 62 across
two successive graphic channel rows. By reference to
Fig. 12 it will be seen that the rows indicated at the
top of Fig. 13 correspond to the rows indicated at the
5 top of Fig. 12. The areas enclosed by the text pixels
with reference to the formable discharge elements are
shown in Fig. 13 where text pixel 31 is formed of the
area including the elements formed by rays 1, 2, 3 and
4 in the graphics A channel rows 3 and 4. Text pixel 32
10 is formed of the area including the elements formed by
rays 5, 6 and 7 in the same rows 3 and 4. Text pixel 33
is formed of the area including the elements formed by
rays 8, 9, 10 and 11 in the same rows 3 and 4. Text
pixel 34 is formed of the area including the elements
15 formed by rays 12, 13, 14 and 15 in the same rows three
and 4. Text pixel 35 is formed of the area including
the elements which are formed by rays 16, 17 and 18 in
the same rows 3 and 4. And text pixel 36 is formed of
the area including the elements formed by rays 19, 20,
20 21 and 22 in the same rows 3 and 4.

Every text pixel of the field of text pixels across
the entire imaging area of the member 64 of which the
text pixel TP1-TP48 illustrated in Fig. 13 are represen-
25 tative, may be operated on one of four ways as has been
described hereinbefore. These four ways result from the
binary combination of one information bit and one control
bit of the digital words of the text data. These four
states or conditions are divided into two modes, the
30 normal mode and the reverse mode. In the normal mode
the text data may inhibit the formation of rays
in any text pixel, this inhibiting the formation of
rays causing to leave the area of that particular text
pixel charged which will be toned and will print solid
35 upon a receptor. The second state of the normal mode is
where the text data enables the formation of rays under
control of the graphics data. The first state of the
reverse mode causes the formation of rays in the area

1 of a text pixel to form a clear text image in a field
of a graphics image. On the receptor then the text will
be clear within the confines of the printed image. The
second state of the reverse mode is where the text data
5 enables the formation of rays under control of the
graphics data to produce a graphics image represented
therein.

It therefore may readily be seen that the second states
10 of the normal and reverse mode simply allow the formation
of the graphics image carried by the graphics data.
That the first state of the normal mode inhibits the
formation of any rays or discharge elements in the entire
area of the text pixels, and the first state of the
15 reverse mode causes the formation of rays or discharge
elements in a text pixel. Thus the member 64 may be
imaged with text data to obtain a resolution which is
three times finer than that obtainable using the graphics
pixels. Further the text and graphics data does not
20 have to be especially formatted; nor does the electronics
have to be constructed or arranged to switch back and
forth between the text and graphics data.

In an manner similar to the predefined positions of the
25 discharge elements of the graphics pixels, there are
predetermined centering points or positions for the
discharge of elements in the text pixels. It may readily
be ascertained by viewing Fig. 13 that not all of the
formable elements in a text pixel may be discharged to
30 clear the total area of a text pixel during the first
state of the reverse mode, only half of the formable
elements. In fact, it may observed in Fig. 13 that only
half of the dischargable elements in any one text pixel
need by discharged to discharge the entire area of that
35 text pixel. This is illustrated in text pixel 43 wherein
there are four discharged elements represented by the
four circles 218. Thus it may be ascertained that by
discharging the elements whose centering points have x

1 or crossed line as is illustrated text pixels TP32-TP36
the entire areas of those text pixels may be discharged.
Thus it may be seen in the reverse mode, in the condi-
tion which causes the formation of rays to discharge
5 the areas of the text pixels, only every other ray need
be formed in any one row of dischargable elements, while
in the next successive row only those elements which
were not formed in the preceeding row need be formed.
Thus in text pixel 31, rays 2 and 4 are formed in row
10 3 while rays 1 and 3 are formed in row 4. Thus to perform
the reverse mode function which causes the formation
of rays to discharge elements of the text pixel, the
electronics need only form alternating rays in alter-
nating rows. The formation of these rays in the reverse
15 mode then may be described as text mode odd and text
mode even, the odd and even referring to the desired
rays which are to be formed in even numbered rows and
the rays which are to be formed in the odd numbered
rows. The implementation of this odd and even arrange-
20 ment will be discussed more fully hereinafter in con-
junction with the electronics.

The text data may be used to form solid printing areas
such as alfanumerics, high receptor and further may be
25 used to print on a receptor line graphics such as
engineering drawings, charts, graphs, etc.

There are two sets of electronics or electrical systems
for the digital platemaker, each electronic system being
30 dedicated and acting in conjunction with only the left
or righthand optical system. The electronics or electro-
nics system is referred to the electronics required to
receive graphics and text data and apply radio frequency
signals to the acousto-optic deflector, which discharges
35 incremental areas on the electrophotographic member 64.
Both electronics systems perform the same functions and
are identical to each other in all respects so that a
description of one electronic system is a description

1 of the other electronic system, and reference to an
electronic system in conjunction with the modulation
of the laser beam in a singular refers to electronic
systems of the left and right hand optical systems.

5 The electronics system illustrated in Fig. 1 generally
illustrates the operation of both the electronic systems
while the electronics system illustrated in Fig. 14 is
a more detailed illustration of the same.

10 Data is input to the electronics system on input leads
250, which are illustrated with arrows having a width
to illustrate that the input data is comprised of digi-
tal words having several parallel bits conveying the
15 desired information. In the preferred embodiment the
data is input to graphics data buffers 32 and 34 and
text data buffers sequentially, that is to say that
buffer 32 is loaded first, buffer 34 is loaded next
and then buffer 36 is loaded last. The data contained
20 in each buffer is the information or density values
required to form graphics pixels along one scan line
and text pixels across an entire image line. Inputting
of the data to the buffers 32, 34 and 36 may be under
control of such as a central controller 252 by way of
25 leads 254. Central controller 252 may be interfaced
with whatever system that the text and graphics data
are supplied from and may take form of a hard wired
controller of a programmable controller as is desired.
In the preferred embodiment, central controller 252
30 is a programmable microprocessor.

During an initialization period before the actual text
and graphics data are input to the digital plate maker
the patterns which are selected by the graphics data
35 are loaded into the pattern generators 38 and 40 by
way of input lead 250 under control of central controller
252. In this initialization period, data in form of the
patterns which are to be loaded in the generators 38

1 and 40 are input into buffers 32 and 34 and carried by
leads 42 and 44, leads 256 and 258 to the inputs of
pattern generators 38 and 40 indicated by arrow heads
260 and 262. Thus, it may be determined that pattern
5 generators 38 and 40 comprise memory devices which may
be loaded, such devices being called random access
memories or RAM. Loading of the pattern generators 38
and 40 is under control of central controller 252 by
way of lead or leads 264. Suitable gating is provided
10 which will be described hereinafter so that the graphics
data carried by leads 42 and 44 to pattern generators
38 and 40 will not interfere with the patterns output
by generators 38 and 40. After the initialization
period has been completed and all the patterns are
15 loaded into the pattern generators, the operational
period of the imaging cycle is commenced in which the
pattern generators become output devices.

Generation of the patterns is in response to graphics
20 data applied to pattern generators 38 and 40 by way of
leads 42 and 44. Control of the generation of patterns
and indication of the location of fine beam 62 along
the scanning line occurs by way of leads 264 from cen-
tral controller 252. Central controller 252 is connected
25 to optical grating system 150 by way of leads 256.

The output of pattern generators 38 and 40 are applied
on leads 48 and 50 to beam logic 46 which also has
applied thereto the text data over leads 52. Control of
30 the beam logic including indication of the position of
fine beam 62 along the scan line is from central con-
troller 252 to beam logic 46 over leads 268.

In the beam logic the modulation of the graphics patterns
35 to be formed by the individual rows are modulated by the
text data as has been described hereinbefore with the
output of the beam logic on leads 56 comprising the
radio frequency signals required to produce the image

1 indicated by the text and graphics data. Generation of
the fine beam 62 and reference beam 118 is as has been
previously described and therefore need not be redes-
cribed. It suffices to say that optical path 270 illus-
5 trated in Fig. 14 generally comprises the optical ele-
ments between the acousto-optic deflector 54 and the
electrophotographic member 64. Reference beam 118 is
diagrammatically illustrated as being part of fine
beam 118, after fine beam 62 exists the optical path
10 270. This is shown for illustration purposes only.

Turning now to Fig. 15, the pattern generators 38 and
40 are more specifically shown as is the gating required
to load pattern generators 38 and 40 during the initial
15 period. Latching line driver 280 is applied with data
on leads 256, which in Fig. 15 are represented by single
lines for clarity of the drawing. During the initial
period in which patterns are loaded into pattern gene-
rator 38, the latching line driver 280 under control
20 of leads 282 allows the data on leads 256 to pass
therethrough and be input by channel A pattern RAM 284
which is placed in the read mode by lead 286. In a like
manner, data which is supplied on leads 258 are applied
to latching line driver 286, which during the initial
25 period pass the data therethrough and it is input by
channel B pattern RAM 288. Channel B pattern RAM is
placed in the read mode also by lead 286. At the end
of the initial period and at the commencement of the
operation of the imaging cycle, latching line drivers
30 280 and 286 have their outputs placed to a tri-state
level which places no load on leads 260, 48, 262 and
50. Thus in the operational period, the data appearing
on leads 48 and 50 will be only the outputs of pattern
RAMS 284 and 288.

35

During the operational period, graphics data is supplied
to pattern generators 38 and 40 by way of leads 42 and
44. The graphics data is input therefrom to channel A

1 latching counter 290 and channel B latching counter 292,
respectively. The input of latching counters 290 and 292
is in the form of parallel words having 8 bits of infor-
mation each. The output of latching counters 290 and 292
5 are 11 bits of information, the 8 most significant bits
of the output being the same as the graphics data input
thereto and the three least significant bits being gene-
rated in response to signals from the optical grating
system. Loading of latching counters 290 and 292 is by
10 way of a load lead 294.

To understand the selection of the patterns from the
pattern RAMs 284 and 288, it must be understood that
the value carried by each graphics data word represents
15 a scaled density of an incremental area which is to be
produced or reproduced on member 64. It further will be
remembered as is illustrated in Figs. 12 and 13, the
graphics pixels have a pattern produced in five sequen-
tial rows, the sixth row being used to space between
20 graphics pixels. Thus to form one pattern in a graphics
pixel, information must be applied to the acousto-optic
deflector one row at a time to form the individual rays
or beamlets required to discharge the elemental areas
and produce the pattern indicated by the pattern RAMS
25 284 and 288. In the preferred embodiment, this generation
of the patterns across the five rows of the graphics
pixels occurs by using the value of the graphics words
to select a group of addresses in the pattern RAMS and
288. Then a row clock signal produced from the signals
30 produced by the optical grating system 150 is used to
clock or step through the selected group of addresses.
The outputs of the pattern RAMS 284 and 288 at each step
of the group of addresses then are the binary indications
of whether an individual ray is to be formed or not.
35 Simply stated, the graphics words are used to select a
group of memory locations while a row clock is used
to step through the locations. The output of the memory
step by step is the information needed to turn on or off

1 the individual rays in fine beam 62.

Thus the clocks for latching counters 290 and 292 are applied on leads 296 and 298. The outputs of the pattern
5 RAMS 284 and 288 are eleven bits of information each which are used to form the 22 individual rays.

The inputs to latching counters 290 and 292 are indicated as graphics data bits GD1-GD8. The outputs of latching
10 counters 290 and 292 and the inputs to pattern RAMS 284 and 288 respectively are indicated as A-channel address leads AA0 through AA10 and B channel address leads BA0 through BA10. The output of pattern RAMs 284 and 288 are indicated as being pattern bits PB1 through PB11
15 and PB12 through PB22.

Concerning the stepping through the groups of memory location, it will be observed that three input bits 300 and 302 respectively of latching counters 290 and 292
20 are tied to ground. Thus when counters 290 and 292 are loaded by way of the signal on lead 294, the outputs AA0 to AA2 and BA0 to BA2 are at zero logic levels. Thus when clock signals are applied on leads 296 and 298, latching counters 290 and 292 respectively count up
25 in binary manner from 0. Referring back to Figs. 11, 12 and 13, it will be noted that the rows are numbered accordingly as binary numbers from 0 to 5, which correspond respectively to the counts produced at the outputs of latching counters 290 and 292. It should further be
30 noted that the rows for the A and B channels of graphics data are shifted relative to one another to form the desired irregular hexagons having apexes interleaved between one another. It therefore should be understood that the clocking of the channel A latching counter 290
35 commences earlier than the clocking of the channel B latching counter 292 to provide the patterns from the respective RAMS at the proper times.

1 The leads 282, 286, 294, 296 and 298 used to control the
functions of the latching line drivers and pattern gene-
rators generally are the leads 264 indicated earlier in
Fig. 14 coming from central controller 252.

5

In Fig. 16, there is illustrated in more detail the beam
logic 46. In Fig. 16, pattern bits 1-22 are illustrated
as being applied to a 22 bit one of four multiplexer 304
on one lead which is indicated as being 48 and 50. This
10 is for clarity of the drawing. While multiplexer 304
is indicated as being one unit, which is able to select
between one of four inputs, in the preferred embodiment
multiplexer 304 is a plurality of multiplexers which
may be individually or jointly operated upon. Beam logic
15 46 further comprises three switch arrays 306, 308 and
310, each of which supplies 22 individual leads of logic
signals with each of the logic signals being controlled
by a resistor switch network such as is illustrated in
each block representing the switch arrays. Basically
20 the network consists of the output lead being tied to
a plus-5 volt source through a 1-K resistor, there being
a programmable switch which may be closed to short the
output lead to ground. When the switch is open, the
logic level of the outputs of the switch arrays are at
25 a logic of 1; while when the switches are closed the
outputs are at logic state zero.

Array 306 is labelled as being the text reverse even
switch array indicating that the outputs of this array
30 indicate which of the individual rays are to be formed
during a reverse mode even row indicated by the text
data. The array 308 is labelled as being a text reverse
odd switch array, the label indicating that the outputs
of this array indicate the individual rays which are to
35 be formed during a reverse mode odd row condition indi-
cated by the text data. Array 310 is labelled as being
a text normal switch array with its outputs indicating
the rays which are to be inhibited. The outputs of each

1 array, TRE1-TRE22, TRO1-TRO22 and TN1-TN22 are applied to the inputs multiplexer 304 over leads 306, 308 and 310 respectively.

5 Text data represented by text data bits TD1-TD8 at 312 of Fig. 16 are applied through a gating 314 to the A and B select inputs of multiplexer 304 on leads 316 and 318. Also applied to gating 314 is address lead AAO from the A channel latching counter 290.

10 The outputs of multiplexer 304 are indicated as being ray data RD1-RD22, each output corresponding to the formation of an individual ray of fine beam 62 and acousto-optic deflector 54 from beam 60. The outputs
15 of multiplexer 304 pass on lead 320 to a 22 bit latch 322, which holds the output data in response to a latch signal on lead 324. The output of the 22 bit latch is applied through leads 326 to 22 individual bit drivers 328, there being one individual bit driver for each of
20 the output bits RD1 through RD22. The 22 bit drivers are enabled by a signal on lead 330 and provide their outputs by way of leads 332 to 22 RF oscillators 334, there being one RF or radio frequency oscillator for each of the signals from bit drivers 328 and the outputs
25 of the 22 RF oscillators 334 appearing on leads 56 and being applied to acousto-optic deflector 54.

In operation of the beam logic circuit, instead of there being a straight forward gating of the pattern bits PB1-PB22 by the bits of the text data TD1-TD8, the bits of
30 the text data are used to select for each of the groups of individual rays indicated in Fig. 13 between the four inputs to multiplexer 304, pattern bits, reverse mode even bits, reverse mode odd bits, and normal mode bits.
35 But to this extent the illustration of multiplexer 304 in Fig. 16, as selecting between one of the four inputs for all of the ray data bits is somewhat misleading.

1 A better illustration of the multiplexing which occurs
is illustrated in Fig. 18 with Fig. 17 illustrating in
chart form which bits of the text data are used to modu-
late the individual rays. In Fig. 18, there is illustra-
5 ted one of four multiplexer 336 having four groups of in-
put bits, one group for each of the ray data bits output
therefrom. As may be seen in Fig. 17, text data 1 is used
to operate on or select the proper output for rays 1-4.
Thus the outputs of one of four multiplexer 336 are indi-
10 cated as being the ray data bits RD1 through RD4, these
of course being the logic signals which determine whether
or not rays 1-4 are formed or not. Thus to produce ray
data bit R1, multiplexer 336 may select one of pattern
bit1, text reverse even bit 1, text reverse odd bit 1 and
15 text normal bit 1. Multiplexer 336 may make a light selec-
tion for each of ray data bits RD2-RD4. It should be re-
membered that when the ray data bits are such as a logic
of 1, they indicate that an individual ray should be for-
med in fine beam 62 while when the ray data bits are at
20 a logic of zero (0), they indicate that no individual ray
should be formed in fine beam 62.

Concerning gating 314 which is illustrated more fully in
Fig. 18, it should be remembered that binary combination
25 of a control bit which is shown in Fig. 17 to be the text
data bit TD7 and an information bit such as text data bit
TD1 which are used to select between the four states. Gat-
ing circuit 314 provides for this in addition for provid-
ing for the turning on of the desired individual rays
30 during a reverse mode and the even and odd rows.

To this end, it will be noted that a signal which is a
logic level 1 indicating that the beam logic is out of
the text mode is applied to norgate 340 to lead 342,
35 that the output thereof is a logic of zero (0) which
is applied to AND gates 344 and 346 on lead 340 respecti-
vely. The outputs of AND gates 344 and 346 thus may only

1 be a logic of zero (0) which would apply to the A and
B outputs of multiplexer 336 selects the pattern bits
to be output as the ray data bits RD1-RD4. The same
thing occurs when the T1 input to norgate 340 is a logic
5 of 1, indicating that the pattern bits generated by the
graphics data are to be formed in the text pixel or
pixels corresponding to rays R1-R4. When the text mode
signal is a logic of zero (0) and the TD1 is a logic of
0 (zero), then the output of Norgate 3-4 is a logic of
10 1, which enables AND gate 344 and 346 to provide signal
which will select other than the graphics data to be
formed in text pixels corresponding to rays R1-R4.

In such a case, if signal TD7 is a logic of 1, indicating
15 a normal mode, then the outputs of norgates 350 and 352
also will be a logic of 1, which is applied respectively
by way of leads 354 and 356 to AND gates 344 and 346. The
outputs of AND gates 344 and 346 then will both be logic
of 1, which will select as the ray data bits RD1-RD4
20 the logical levels appearing on the signals labelled
TN1-TN4 or text normal. The outputs from the text normal
switch array 310 illustrated in Fig. 16 thus must be
programmed in logical zeros (0's) so that the formation
of individual rays R1-R4 is inhibited. It may be stated
25 at this time that switch arrays 306, 308, 310 are provided
in the preferred embodiment to provide versatility
of the apparatus.

Further in the case where the signals on lead 342 and
30 the logic level of bit TD1, the logical zeroes, if the
TD7 signal is a logical zero indicating the reverse mode,
then the outputs of Norgates 350 and 352 will be controlled
by the logical level input thereto by the A channel
address bit zero, A-A zero. It will be understood
35 that this signal A-A zero is continuously being oscillated
between a logic of zero and a logic of 1 state, as the
fine beam 62 is passed across the surface of the electro-
photographic member 64. Thus when bit TD7 is a logical

1 zero, the output of Or gate 350 is directly controlled by
the logical level of signal A-A zero, while the output of
Or gate 52 is the inverse thereof due to inverter 358.
Thus for an even row, the outputs provided by AND gates
5 344 and 346 will be such that multiplexer 336 outputs as
ray data bits RD1-RD4 the logical levels appearing at the
signals TRE1 through TRE4. At an odd number row, logic
levels output by multiplexer 336 as ray data bits RD1-RD4
will be the logical levels input thereto by signals
10 TRO1-TRO4.

It will be appreciated that the one of four multiplexer
used to form the ray data bit RD1-RD4 is an example of
the multiplexer circuit used to provide the ray data bits
15 for each of the groups of rays illustrated in connection
with the text pixels of Fig. 13. The gating circuit 314
also is the same for each of those multiplexer circuits
with only the information bit TD1 being changed for
the groups of rays to the corresponding text data bit.
20

After the electro-photographic member 64 has been charged
at charging station 70 and has been imaged with fine
beam 62, the latent image carried thereon is toned at
toning station 72, which is a portion of the vertical
25 toning system of the digital platemaker.

The vertical toning system may best be understood by
considering that its purpose is to apply toner (carrier
fluid having suspending therein toner particles) to the
30 electro-photographic member 64. The areas of member 64
which remain charged after imaging are the areas which
accept the toning particles. The toned member thereafter
has the toned particles fused to the member for use as
a printing plate in such as a lithographic printing press,
35 but this fusing step occurring otherwise than
in the digital platemaker

The toner which is supplied to the electrophotographic

1 member is in the form of a carrier fluid known as "ISOPAR",
which is a registered trademark of the Exxon Corporation.
The carrier fluid carrying finely ground particles of
resinous material which may be positively or negatively
5 charged and in the preferred embodiment herein the
particles are positively charged. Hereinafter, the term
"toner fluid" will refer to this carrier fluid containing
the resinous toner particles, while the term "carrier
fluid" will refer only to the "ISOPAR" without the
10 resinous particles.

As has been stated, the member 64 is mounted on drum 66
and is rotated thereby past charging station 70, imaging
plane represented by the fine beam 62 and the toning
15 station 62, at which the toner fluid is applied to the
member.

It will be noted that electrophotographic member 64
comprises a substrate carrying a photoconductive coating,
20 the substrate in the preferred embodiment being a magne-
tic material such as stainless steel and the electro-
photoconductive coating being the coating disclosed
and claimed in U.S. Patent 4,025,399, which has been
incorporated herein by reference. The member is held in
25 the drum by magnetic strips embedded at the outer circum-
ference of the drum, of course, other hold-down systems
such as vacuum systems could be used to maintain the
member in fixed relationship to the outer circumference
of the drum. These other systems could further include
30 clamps, springs, etc.

As the member rotates past the toning station 72, there
is first applied thereto a quantity of carrier fluid
which wets the surface of the member for purposes which
35 will be described hereinafter. This wetting of the surface
occurs at what may be called an upper chamber of the
toning station 72. Thereafter, the toner fluid is applied
to the member into phases which may be referred to as the

1 initialization phase and the operational phase. During
the initialization phase, a meniscus of toner fluid is
established between toning station 72 and member 64,
while during the operational phase, the meniscus is
5 maintained between the toning station 72 and the member.
It should be noted, as illustrated in Fig. 1, toning
station 72 is essentially vertical along the circum-
ference of drum 66, and thereby the meniscus established
between toning station 72 and member 64 is essentially
10 vertical.

Turning now to Fig. 19, there is shown in block diagram
form the toning system which is indicated generally by
the reference character 400. The toning station 72
15 illustrated in the earlier drawings comprises left and
right hand shoes 402 and 404, respectively. It is the
shoes which are used to apply the toner fluid to the
member 64, and it is between the shoes and the member 64
then the vertical meniscus is established and maintained.
20 As may be readily understood, the left-hand shoe 402 is
used in conjunction with the left hand optical system 82,
while the right hand shoe 404 is used in conjunction
with the right hand optical system 84. It will be under-
stood that an explanation of the toning system for the
25 right-hand optical system is an explanation of the toning
system for the left-hand optical system, the toning
systems for both sides being more or less exactly the
same for both sides. Thus Fig. 19 is a block diagram
of both the left and right hand toning systems, although
30 only one set of elements is illustrated.

During the initialization phase, carrier fluid is supplied
from reservoir system 406 to the right hand shoe 404 by
way of tubing 408 under action of pump 410. Pump 410 ope-
35 rates in response to or under control of controller 412
by way of lead 414. Toner fluid is carried to right hand
shoe 404 from the pressure system 416 by way of tubing 418
under control of pump 420, pump 420 being controlled in

- 1 turn by controller 412 by leads 422. Excess toner fluid is returned to pressure system 416 from right hand shoe 404 by way of tubing 424.
- 5 Used toner fluid is carried to sump system 426 by way of tubing 428, sump system 426 being at a vacuum or having a vacuum with which to remove the used toner fluid from the member. Used toner fluid contained in sump system 426 may be returned to the reservoir system 406 by way of
- 10 tubing 430 by action of pump 432, pump 432 in turn being controlled by controller 412 by way of leads 444.

After the meniscus has been established during the initialization phase, valve 436 is used to admit air into

15 pressure system 416 over tubing 438 to aid in the maintenance of the meniscus between the shoe 404 and the member 64.

It is important that the application of the carrier and

20 toner fluids and the operation of the vacuum sump system occur at the proper time intervals as the member 64 is rotated past the shoe 404 and to obtain the timing information and sensor 440 is coupled to drum 66 and supplies the timing information to controller 412 by way of leads

25 444.

The toning station 72 is generally illustrated in Fig. 20 wherein left and right hand shoes 402 and 404 are carried by backplate 440. The back plate 440 carries four rollers,

30 442, two at each end which are in rolling contact with drum 66 along surfaces 444. Rollers 442 are adjustable by way of a cam mounting to adjust the spacing between shoes 402, 404, and drum 66. The spacing required between the shoes 402, 404 and drum 66 must be sufficient for the

35 electrophotographic members 64 to pass there between and there must be additional spacing to provide for the meniscus of toner fluid established therebetween.

1 Toning station 72 has two positions, one being with the
rollers engaged against the surfaces 444 of drum 66 during
an imaging and toning cycle, and the other position being
spaced from the drum and at a level below the drum in a
5 non-toning position. A pneumatic or hydraulic cylinder
446 is provided to move the toning station 72 between
these two positions and further is used to provide the
toning station 72 between these two positions, and
further is used to provide a slight bias to maintain
10 rollers 442 in contact with surfaces 444. Rollers 442
are engaged against surfaces 444 at the two longitudinal
ends of drum 66 so as not to interfere with member 64
which is carried on drum 66 therebetween. Of course any
surfaces as may be desired may be provided upon which
15 the rollers of plate 440 may ride.

Right hand shoe 404 has as is illustrated in Fig. 21,
is essentially a rectangular solid with a surface 446
which is to be placed adjacent the drum 66, having a
20 portion 448 which is concave. The radius of this concave
portion 448 is essentially equal to the radius of the
drum 66 so that the concave portion 448 may be spaced
equidistant from drum 66 across the entire area of the
concave portion 448.

25 A seal member 450 is mounted on shoe 404 at the concave
portion 448. This seal member 450 generally has the
shape of a H with the cross-bar of H being biased towards
the top of the seal. The seal is made from a resilient
30 material such as polyurethane and is mounted into slots
extending into the shoe. The seal is constructed so that
when the shoe 404 is in the toning position, the edges
of the seal 450 extending furthest from the shoe are
engaged against the outer surface of the electro-photo-
35 graphic member 64.

The cross-bar 452 of the seal 450 separates the concave
portion 448 into upper and lower portions 454 and 456.

1 In the upper portion 454, clear carrier fluid is applied
to the member 64 for several reasons. These include
precoating or wetting the member 64 with this wetting
acting as a barrier against toner particles which are
5 not charged to reduce fogging of the latent image and
further provides a lubricant for the seal 450 to reduce
wear of the seal, improve the sealing characteristics
thereof and reduce the power which would otherwise be
required to be supplied by motor 90 to drive the drum
10 66.

Cross-bar 52 is constructed to provide a wiper blade
portion 458 which allows only a microscopic coating
of the carrier fluid to be applied to the member 64
15 as it passes thereby. Of course, the wiper blade portion
458 as it is wiped across the member 64 does not disturb
the quality or characteristics of the latent image
carried thereon. It will further be appreciated that
the carrier fluid also does not affect the quality
20 of characteristics of the latent image on member 64.

The upper portion 454 comprises an upper chamber 460
extending into shoe 404 and opening to concave surface
448. Supply ports 462 are arranged spaced from one
25 another along the inner wall of a upper chamber 460
supply carrier fluid transported by tubing 408 from
reservoir system 406, which is supplied thereto for
application to the member 64. A baffle 464 shown in
Fig. 22 is contained in upper chamber 460 so that
30 carrier fluid from ports 462 may be evenly supplied
to member 64 across the length of chamber 460.

The lower portion 456 of the concave portion 448 is the
portion where toner fluid is applied to member 64. A
35 lower chamber 466 extends into shoe 404 and opens to
concave portion 448. Chamber 466 extends essentially
the length of the shoe. It will be noted that the cross-
bar 452 essentially is the dividing between divides

1 the upper and lower portions 454 and 456. Toner fluid is
applied to lower chamber 466 by the way of inlet ports
468, spaced along the length of chamber 466 with the
toner fluid being supplied from pressure system 416 by
5 way of tubing 418. A baffle 470 may be provided in lower
chamber 466 to evenly supply toner fluid to member 64
from the individual inlet ports 468.

From lower chamber 466, toner fluid may flow down in the
10 direction indicated by arrow 472 along concave portion
448 to vacuum slot 474.

A vacuum slot 474, a reduction in atmospheric pressure
of vacuum is created by sump system 426 by way of tubing
15 428. This vacuum operates to remove toner fluid from both
member 64 and shoe 404 as the toner fluid flows down
along the concave portion 448. From vacuum slot 474, to-
ner fluid is carried to sump system 426 by tubing 428.

20 It should be noted then there are outlet ports 474
spaced along the length of lower chamber 466 and against
the inner wall thereof, as is illustrated in Fig. 22.
These outlet ports 474 provide for return of excess
toner fluid by way of tubing 424 to pressure system
25 416. It also should be noted that the vacuum provided
by sump system 426 may be formed by any means desired.

Fig. 22 generally illustrates the angular relationship
between charging station 70, the incidence of fine
30 beam 62 on member 64, and the position of shoe 404. In
the preferred embodiment, the angle between the center
line of charging station 70 and fine beam 62 is 25° .
The angle between fine beam 62 and the center line of
shoe 404 is 30° . While these angles are indicative of
35 the preferred embodiment, it is desired to reduce these
angles to be as small as possible so that there is a
minimum time between the charging of the member 64 and
the toning of the latent image on member 64.

- 1 It may be seen in Fig. 22 that charging station 70
comprises a charging wire 480 with a guard 482 forming
a threesided channel which is open towards drum towards
drum 66. Wire 480 of course extends along the length of
5 drum 66 as does guard 482. In the preferred embodiment,
wire 480 carries a negative voltage and cover, 482 may
be made of conductive material and forms an electrostatic
mirror.
- 10 Circle 484 along the interface between drum 66 and 244
is shown enlarged in Fig. 23 to illustrate the relative
positions between drum 66, electrophotographic member 64,
toner fluid 486 and shoe 404. The relative thicknesses
of the elements are expanded in Fig. 23 for illustration
15 purposes.

The operation of the toning system may best be understood
by considering that as has been stated there are phases
to its operation. The first phase is known as the initial
20 phase, and during this phase, the toner system establishes
a meniscus of toner fluid between shoe 404 and member 64.
During the operation phase this meniscus is maintained
between member 64 and shoe 404, and is allowed to flow
in the direction indicated by arrow 472 at a controlled
25 rate essentially equal to the angular rotation of the
drum. Thus as member 64 is moved past chamber 466, it
supplies toner fluid to the meniscus. A quantity of toner
fluid is applied against member 64 and remains stationary
relative to member 64, until it is removed as vacuum
30 slot 474. Thus, there is a minimum amount of sheer bet-
ween the meniscus and member 64 which provides for
suitable toning of the latent image with the toning
particles.

- 35 At this point, it will be discussed how the pre-wetting
reduces the fogging of the latent image. The toner fluid,
as has been said, contains particles of resinous material.
These particles are very sticky in that they will readily

1 adhere to most any surface they are brought into contact.
Now when the toner fluid is manufactured, these particles
are given in this case, a positive charge so that they
will be attracted only to the areas which retain their
5 negative charge from charging station 70. Not all of
these particles however remain charged by the time they
are used in the toning system herein.

When the toning fluid is used in the toning system, the
10 charged particles readily are attracted to the oppositely
charged areas of the latent image carried by member 64.
The non-charged particles however are not so attracted and
will stick to any surface to which they may come into
contact with. By pre-wetting the surface of member 64, a
15 barrier is formed through which these non-charged particles
generally will not pass. Although this pre-wetting is
referred to as a barrier the action which is involved is
more along the lines of the non-charged particles not
passing through the pre-wet because there is no force which
20 will drive them through the pre-wet.

During the initial phase of the toning cycle toner fluid
is applied to the lower chamber 466 and falls essentially
by means of gravity into the space established between
25 concave portion 448 and member 64. The rate at which
toner fluid is supplied to chamber 466 is much greater
than the rate at which toner fluid may flow between
concave surface 448 and member 64 with excess toner
fluid being returned to the pressure system 416 through
30 the outlet ports 476 by way of tubing 424. Pressure system
416 is sealed from the atmosphere and as toner fluid is
removed from the pressure system by way of the meniscus
which is formed between concave surface 448 and member 64,
a negative pressure is formed in the pressure tank. When
35 this negative pressure reaches a magnitude of from two to
three inches of water, the toner fluid ceases to flow
between the concave surface and the member 64. Air control
valve 436 which is preset to allow a controlled and

1 predetermined amount of air into the closed pressure
system 416, then controls the flow rate of the toner
fluid in the meniscus between the concave surface 448
and member 64.

5
If the air flow control valve 446 were to be closed,
the meniscus would essentially remain stationary in the
vertical position discounting of course losses from the
lower edge thereof occurring from gravity and from the
10 vacuum slot 474. As the air flow control valve 436 is
opened, the rate of flow of toner fluid through the ver-
tical meniscus increases. The establishment of this ne-
gative pressure in the pressure system 410 and the
simultaneous establishment of the meniscus between concave
15 portion 448 and member 64 is what has been defined to be
the initial phase. Once the initial phase is completed,
operation of the toning occurs through what has been
described the operation phase. It should be understood
that there are not two separate phases which are in
20 operation of the toning system, but rather two phases
which are used to describe the operation of the toning
system.

The rate at which air is allowed into the pressure system
25 416 through control valve 436 is predetermined so that
the flow-rate of toner fluid therebetween occurs at the
same speed as the angular rate of rotation of drum 66.
Thus the toner fluid flows essentially stationary to the
member 64. As the lower edge of the meniscus approaches
30 the vacuum slot 474, toner fluid less the toner particles
attracted to the member 64 by the latent image is removed
from the member 64 with the described atmospheric vacuum.

In summary, the vertical toning system provides a meniscus
35 of toning fluid which is essentially vertical and which
is essentially stationary relative to the movement for
the electrophotographic member 64 to provide toning of
the latent image on the member 64. Control of the flow

1 of the meniscus relative to the member may be easily
controlled through a suitable air control valve 436
and the toner fluid is applied to member 64 after a
period of time which is relatively short after imaging
5 of the member has occurred.

It will be noted that clear carrier fluid is indicated
in upper chamber 460 by reference character 490, while
toner fluid is indicated in the lower chamber 466 by
10 reference character 46.

In the preferred embodiment, the meniscus has a thickness
or the concave portion 48 as spaced from member 64 a
distance of about $13/1000$ of an inch. Shoe 404 may be
15 made of any material which is nonreactive to the "ISOPAR"
carrier fluid, such as aluminum or stainless steel. It
further should be noted that when the toning station 72
is removed from being adjacent drum 66 to the non-toning
position, the vacuum which is created at vacuum slot
20 474 is increased to clear off both the shoe and the
member.

It is important that the commencement of the flowing
of the carrier fluid and toner fluid to the shoe occurs
25 at the proper time in relationship to the movement of
the member 64 across the shoe 404. If these fluids are
applied to the shoe too early, they are not contained
within the seals provided by seal member 450 and may
cause a mess while if the fluids are applied too late,
30 the seals may stick to the member 64.

Referring back to the description of the electronics,
one method of forming the graphic pattern in pattern
generators 38 and 40 is described and claimed in a
35 copending application Serial No. 11,320 filed
February 13, 1979 and entitled DIGITAL LASER PLATEMAKER
AND METHOD, the applicant being Lysle D. Cahill which
application is incorporated herein by reference.

- 1 Referring back to the two toner shoes 402 and 404, it is
entirely possible that one toning shoe could be used in
place of the two shoes.
- 5 Modifications and variations of the present invention
are possible in light of the above teachings. It is
therefore to be understood that within the scope of the
apended claims the invention bay be practiced otherwise
than is specifically described. What is claimed and de-
10 sired to be secured by Letters Patent of the United
States is:

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1 CLAIMS:

1. A method of imaging an electrophotographic member with an array of discharged elements of the surface of the member of such configuration and placement as to enable the member to be used for reproducing graphics and text images upon a receptor by printing or the like in which discharged elements individual to the graphics and discharged images individual to the text images are continuously produced intermixed, said method comprising:
- 15 A. acquiring graphics data in the form of a series of graphics digital words from a source of such words representative collectively of the graphics image, each word corresponding to a predetermined scaled density of an incremental area of the graphics image;
 - 20 B. acquiring text data in the form of a series of text digital words comprised of bits from a source of such words representative collectively of the text image, each word corresponding to a group of predetermined binary densities of a plurality of area of the text image;
 - 25 C. charging an electrophotographic member upon which the graphic and text images are to be reproduced in the form of discharged elements;
 - 30 D. providing a fine beam of radiant energy consisting of a group of individual rays and directing the beam against the electrophotographic member to cause discharge of elements thereof, each ray being capable of discharging a single element if not extinguished when impinging against the member;
 - 35 E. moving the beam and the electrophotographic member with respect to one another in accordance with an arrangement to scan the surface and adapted to have discharged elements in rows and columns on said surface wherever said rays not extinguished have impinged,

1 F. said fine beam being modulated as to its rays
during the relative movement in the following
manner;

5 i. generating control signals from the text
digital words,

ii. generating graphics pattern density signals
representative of respective different
graphics digital words,

10 iii. modulating the rays with said pattern signals
and

iv. controlling the said modulating by the
control signals from the text digital words,
whereby independent graphics and text latent
images may be laid down upon said electrophoto-
15 graphic member surface in one scanning thereof
by said fine beam.

2. An apparatus for imaging an electrophotographic member
with an array of discharged elements of the surface of
20 the member of such configuration and placement so as to
enable the member to be used for reproducing graphics and
text images upon a receptor by printing or the like in
which discharged elements individual to the graphics and
discharged images individual to the text images are
25 continuously produced intermixed, said apparatus com-
prising:

graphics buffer means for receiving graphics data
in the form of a series of graphics digital words from
a source of such words representative collectively of
30 the graphics image, each word corresponding to a pre-
determined scale density of an incremental area of the
graphics image;

text buffer means in the form for receiving text
data in the form of a series of text digital words
35 comprised of bits from a source of such words represen-
tative collectively of the text image, each word corres-
ponding to a group of predetermined binary densities
of a plurality of area of the text image;

1 pattern generator means receiving in seriatum the
graphics data one digital word at a time for generating
a response thereto, graphics pattern density signals
representative of respective different graphics digital
5 words;

beam logic means for producing beam logic control
signals in response to said graphics pattern density
signals, the beam logic means also receiving the text
digital words in modulating the graphics pattern density
10 signals in response thereto to form the beam control
signals;

means for providing a fine beam of radiant energy
consisting of a group of individual rays and directing
the beam against the electrophotographic member to
15 cause discharge of elements thereof, each ray being
capable of discharging a single element if not extin-
guished when impinging against the member;

and modulating the rays with said beam modulation
signals whereby independent graphics and text latent
20 images may be laid down upon said electrophotographic
member surface and one scanning thereof by fine beam.

3. A method of imaging an electrophotographic member with
an array of discharged elements of such configuration
25 and placement to enable the member to be used for pro-
ducing graphics and text images upon a receptor by
printing, said method comprising:

30 A. acquiring graphics data in the form of a series
of graphics digital words from a source of such
words representative of the graphics image, each
word corresponding to a predetermined scaled den-
sity of an incremental area of the graphics
image;

35 B. acquiring text data in the form of a series of
text digital words comprised of bits, from a
source of such words representative of the text
image, each word corresponding to a group of

- 1 predetermined binary densities of a plurality
 of areas of the text image;
- C. providing a beam of radiant energy;
- 5 D. charging an electrophotographic member upon which
 the graphic and text images are to be reproduced;
- E. discharging the electrophotographic member selec-
 tively by a fine beam of radiant energy from the
 beam of radiant energy which forms graphic pixels
10 and text pixels over the area of the member, the
 member and fine beam being moved relative to one
 another in a predetermined pattern of movement,
 said fine beam generally being a composite of a
 plurality of individual rays but at times being
15 as little as a single ray;
- F. generating sample signals which are indicative of
 the relative movement;
- G. providing a store of area weighted graphics pat-
 terns, each graphics pattern being individual to
20 a predetermined scaled density of a graphics
 pixel which is to be reproduced upon the member;
- H. applying the graphics digital words and the sample
 signals simultaneously to the store, each graphics
25 word being applied while a sequentially produced
 group of a first particular number of the sample
 signals is applied , the graphics words each being
 effective to select a group of signals representa-
 tive of a particular graphics pattern which will
30 result in the graphics pixel upon the application
 of the rays;
- I. the sample signals being effective to control the
 rows in the graphics pixel where there will be
 discharged elements to form the pattern within
35 the graphics pixel and the areaweighted pattern
 chosen by the graphics word being effective to
 control the columns of the graphics pixel where
 there will be discharged elements to form the

- 1 pattern;
- 5 J. the output from the store comprising, for each graphics word and each row chosen, a plurality of graphics beam modulating signals describing the discharge elements for the graphics pixel,
- 10 K. providing an array of binary text patterns, each text pattern being individual to a binary density of a text pixel which is to be reproduced upon the member and the output of the array comprising a plurality of constant text beam modulating signals describing the discharge elements for every row of the text pixels;
- 15 L. applying the graphics and text beam modulating signals, the text digital words and the sample signals simultaneously to a multiplexer, each text word being applied while a sequentially produced group of second particular number of the sample signals is applied, the text beam modulating signals being constantly applied, the graphics beam modulating signals being sequentially applied as they are output from the store, and the bits of the text words being effective to select in groups of beam modulating signals for each row, one of
- 20 the graphics and text beam modulating signals to be output from the multiplexer as output beam modulating signals;
- 25 M. splitting the beam of radiant energy into the plurality of rays in response to the output beam modulating signals and directing the rays as the fine beam against the electrophotographic member to form the graphics and text pixels on the member, and
- 30 N. effecting the formation of graphics and text pixels on the member for all the digital words of the graphics and text data.
- 35

1 4. An optical system for use in imaging at a scan line
an electrophotographic member which is charged to form
a latent image of charged and discharged areas the member
thereafter being used as a printing plate, the optical
5 system including:

means for supplying a beam of radiant
energy;

splitter means for splitting from the
beam a reference beam of radiant energy;

10 modulator means for deflecting individual rays from the beam of radiant energy in
response to electrical signals applied thereto,
the individual rays forming a fine beam;

alignment means for aligning the fine
15 beam and reference beam vertically, one above
the other;

Locus means providing as objects of
the reference and scanning beam,

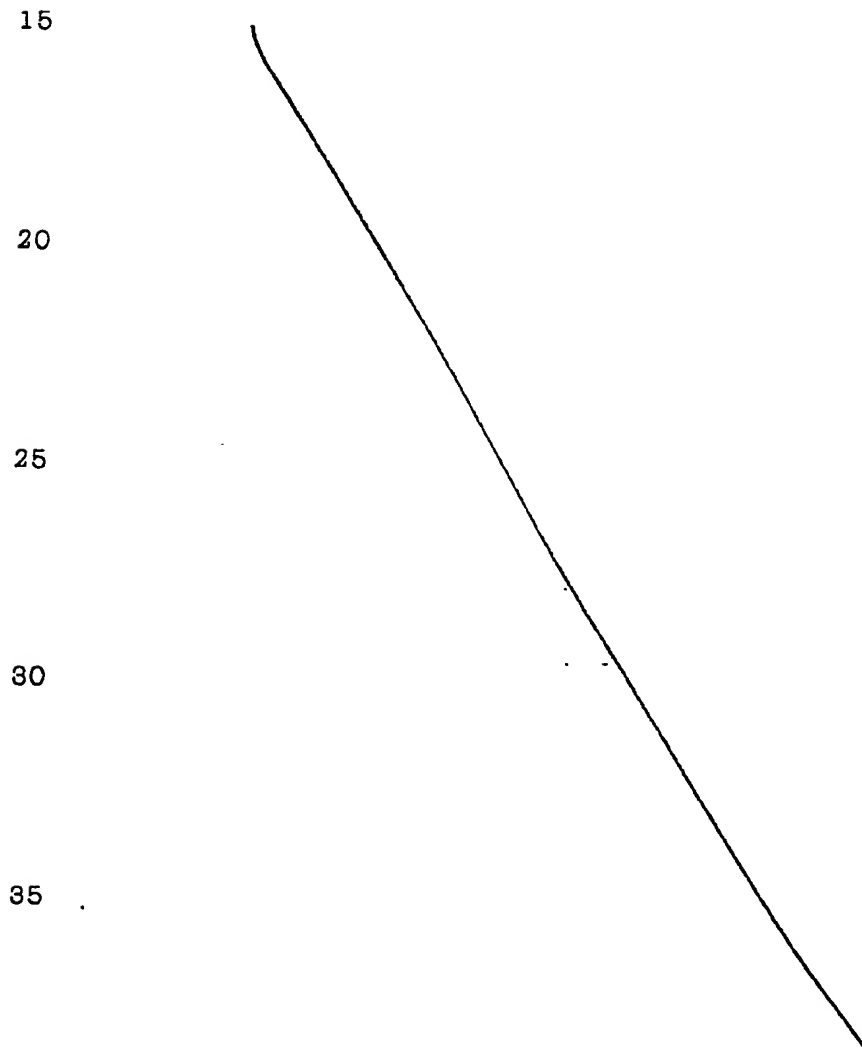
20 lens means arranged centered with the
latent image to be formed on the member and
perpendicular to the scan line;

mirror means which is rotatable for
reflecting the reference and scanning beams which
pass through the lens means back through the lens
25 means and onto the member along the scan line;

deflection means for deflecting the
reference beam and scanning beam through the
lens means along a path centered with the member
but at a level below the scan line;

30 the lens means providing field flattening of the reference and scanning beams passed
therethrough and back again by the mirror means
to maintain a focused image on the member along
a scan line in response to the objects, and the
35 scanning beam being reflected by the mirror means
along the scan line with the reference beam being
reflected above the scan line.

- 1 5. A field flattening lens for use in an optical imaging
system wherein a beam of radiant energy is passed through
the lens and back through the lens by a mirror which de-
flects the beam across a scan line, the lens comprising:
- 5 a plurality of lens groups comprising
from the object to the image end a first positi-
ve group having a concave object side surface,
a second positive group having a concave object
side surface, a third positive group having a
flat object side surface, and a fourth group
10 having a flat concave side surface to provide
field flattening of the beam of radiant energy
along the scan line.



- 1 6. The lens as claimed in claim 5 defined substantially by the following data, where the elements L1, L2, L3 and L4 comprise respectively the first, second, third and fourth groupings:

5	<u>LENS</u>	<u>Radius</u>	<u>Axial Distance Between Surfaces (mm)</u>	<u>N</u> <u>d</u>	<u>V</u> <u>d</u>
	R1	-161.744			
	L1		15.00	1.617	36.6
	R2	00			
10			6.97		
	R3	-216.311			
	L2		28.871	1.523	58.6
	R4	-213.119			
			0.20		
15	R5	-2575.204			
	L3		18.06	1.523	58.6
	R6	-264.288			
			0.20		
	R7	00			
20	L4		13.00	1.523	58.6
	R6	-265.847			

where L1-L4 are lens elements from the object to the image end, R1-R8 are the radii of the surfaces of the lens elements,

N_d is the index of refraction, V_d is the Abbe number of elements L1 through L4.

- 30 7. For use in an optical grating system, in which a beam of radiant energy is scanned in along a plane across an elongate grating of alternating opaque and transparent spaces, and the radiant energy being transmitted through the transparent spaces, a collector for
35 collecting the radiant energy transmitted by the grating across the length of the grating and applying the collected radiant energy to a sensor, the collector comprising:

1 an elongate, cylindrical bar made of
transparent material arranged with its center
in the plane scanned by the beam and carrying
a narrow stripe of reflective material in a line
5 in the plane scanned by the beam, the remainder
of the circumference of the bar being clean and
smooth,

 and the sensor being arranged at one
of the flat ends of the bar but sensing only a
10 portion of that end centered around the center
of the bar so that radiant energy transmitted
through the grating passes through the diameter
of the bar to strike the reflective material and
cause a Lambertian reflection of the radiant
15 energy to direct the radiant energy to the sensor.

8. A method of toning with a toning fluid an electro-
photographic member carrying a latent image of charged
and discharged areas, the method comprising:

20 providing a chamber adjoining at least
a portion of the member carrying the latent image,
the chamber being defined by the member, an
essentially vertical wall spaced from and paral-
lel to the member, and a seal carried by the
25 vertical wall and engaging against the member,
the seal extending around opposite ends and the
top of the chamber so that the chamber is essen-
tially sealed to the atmosphere and so that the
chamber is open to the bottom and is essentially
30 vertically aligned;

 providing a supply system which is
sealed to the atmosphere containing a quality
of toning fluid and able to supply toning fluid
to the top of the chamber opposite the bottom
35 opening of the chamber the supply system inclu-
ding a controllable valve through which atmos-
phere may be admitted to the system;

1 moving the member relative to the
chamber in a downward direction at a predeter-
mined speed with the seals maintaining the
chamber essentially sealed to the atmosphere;
5 supplying toning fluid to the top of
the chamber from the supply system, the toning
fluid moving from the top of the chamber to the
bottom of the chamber under the force of gravity,
the toning fluid which is moving down through the
10 chamber and thereby being removed from the supply
system causing a negative atmospheric pressure
is the supply system and when the negative pres-
sure in the supply system equals the weight of
the toning fluid moving down through the chamber,
15 the toning fluid being held stationary and in
equilibrium in an essentially vertical meniscus
filling essentially the volume of the chamber;
admitting atmosphere to the supply
system at a controllable rate to reduce the
20 negative pressure in the supply system so that
the toning fluid may move down through the
chamber; and
controlling the rate of atmosphere
being admitted to the supply system so that the
25 speed of movement of the toning fluid in the
chamber is essentially equal to the speed of
movement of the member, thereby the toning fluid
remaining essentially stationary relative to
the member so that the toning fluid may tone
30 the latent image carried on the member.

9. Apparatus for toning with a toning fluid an electro-
photographic member carrying a latent image of charged
and discharged areas the method comprising:

35 shoe means adjoining at least a portion
of the member carrying the latent image, the
shoe means providing an essentially vertical
wall spaced from and parallel to the member,

1 a seal carried by the vertical wall and extending outward therefrom to engage against the member on three sides, the member, the seal and the vertical wall defining a downwardly opening
5 chamber essentially sealed to the atmosphere except at the bottom opening with the chamber being essentially vertically aligned,

supply means coupled to the shoe at the top of the chamber, the supply means being otherwise sealed to the atmosphere except to the
10 opening to the top of the chamber and containing a quantity of toning fluid which is able to supply to the top of the chamber, the supply means including a controllable valve through
15 which atmosphere may be admitted to the system;

means for moving the member relative to the chamber in a downward direction in a predetermined speed with the seals maintaining the chamber essentially sealed to the atmosphere;

20 pump means for supplying toning fluid to the top of the chamber from the supply system, the toning fluid moving from the top of the chamber to the bottom of the chamber under the force of gravity, the toning fluid which is
25 moving down through the chamber as thereby being removed from the supply system causing a negative atmospheric pressure in the supply system, and when the negative pressure in the supply system equals the weight of the toning fluid moving
30 down to the chamber, toning fluid being held stationary and in equilibrium in an essentially vertical meniscus filling the volume of the chamber; and

35 control means operating the controllable valve to admit atmosphere to the supply system at a controlled rate to reduce the negative pressure in the supply system so that the toning fluid may move down through the cham-

1 ber with a speed of movement of the toning fluid
in the chamber essentially equal to the speed
of movement of the member so that the toning
fluid remains essentially stationary relative
5 to the member as it flows down through the cham-
ber with the toning fluid toning the latent
image carried on the member.

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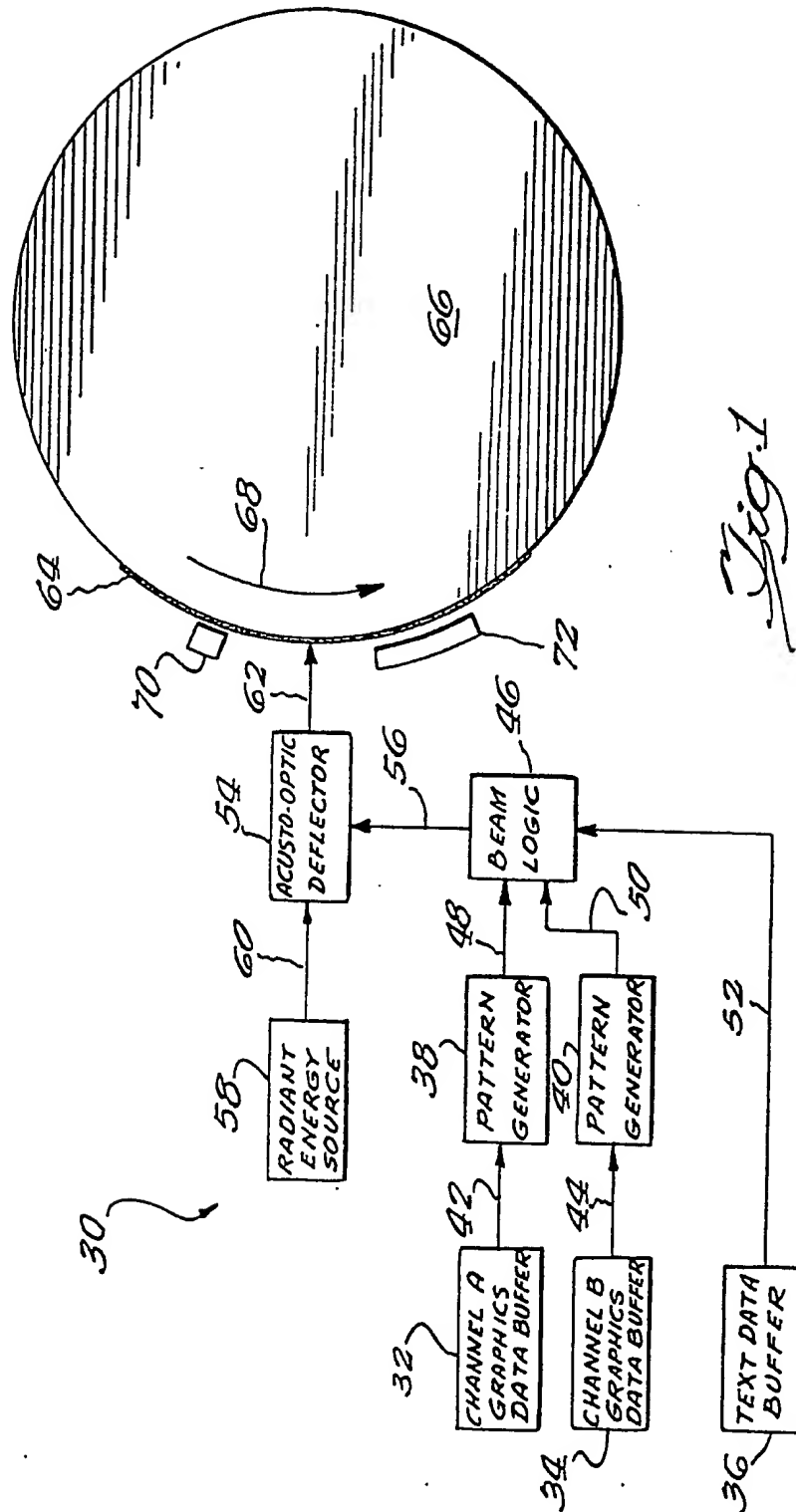
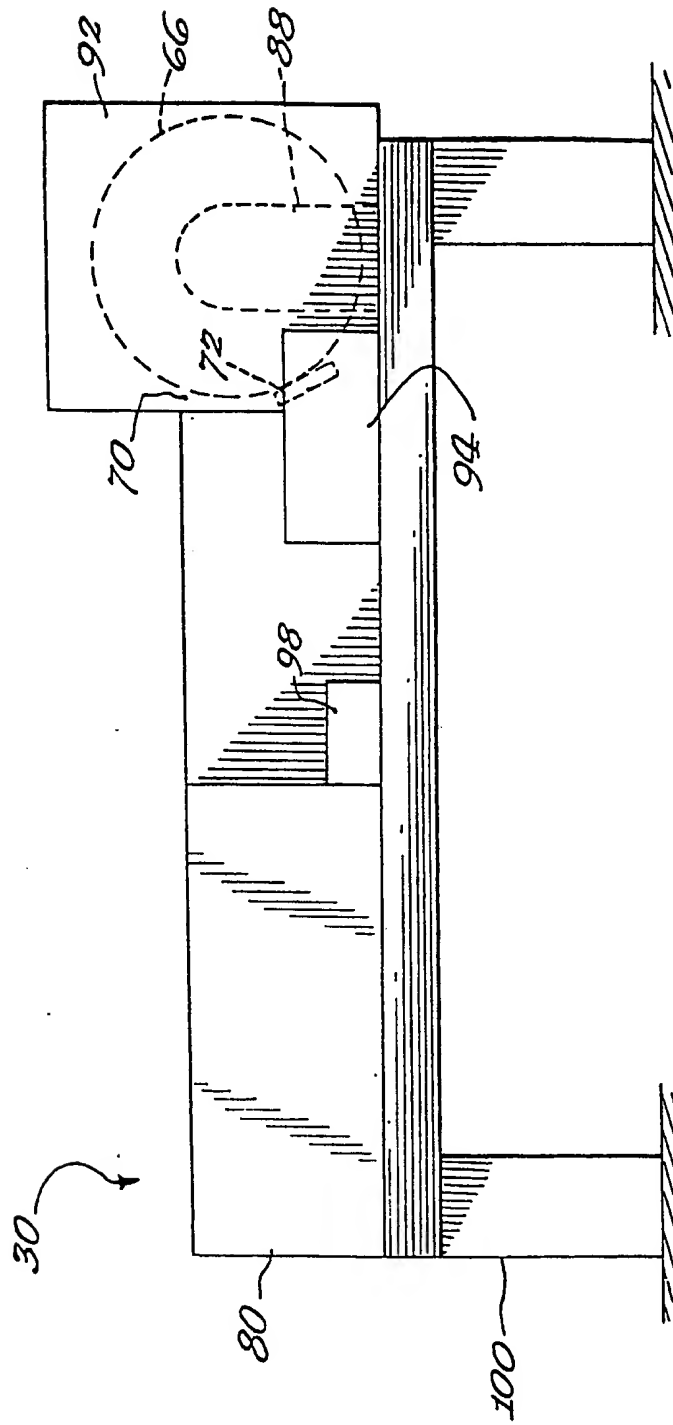
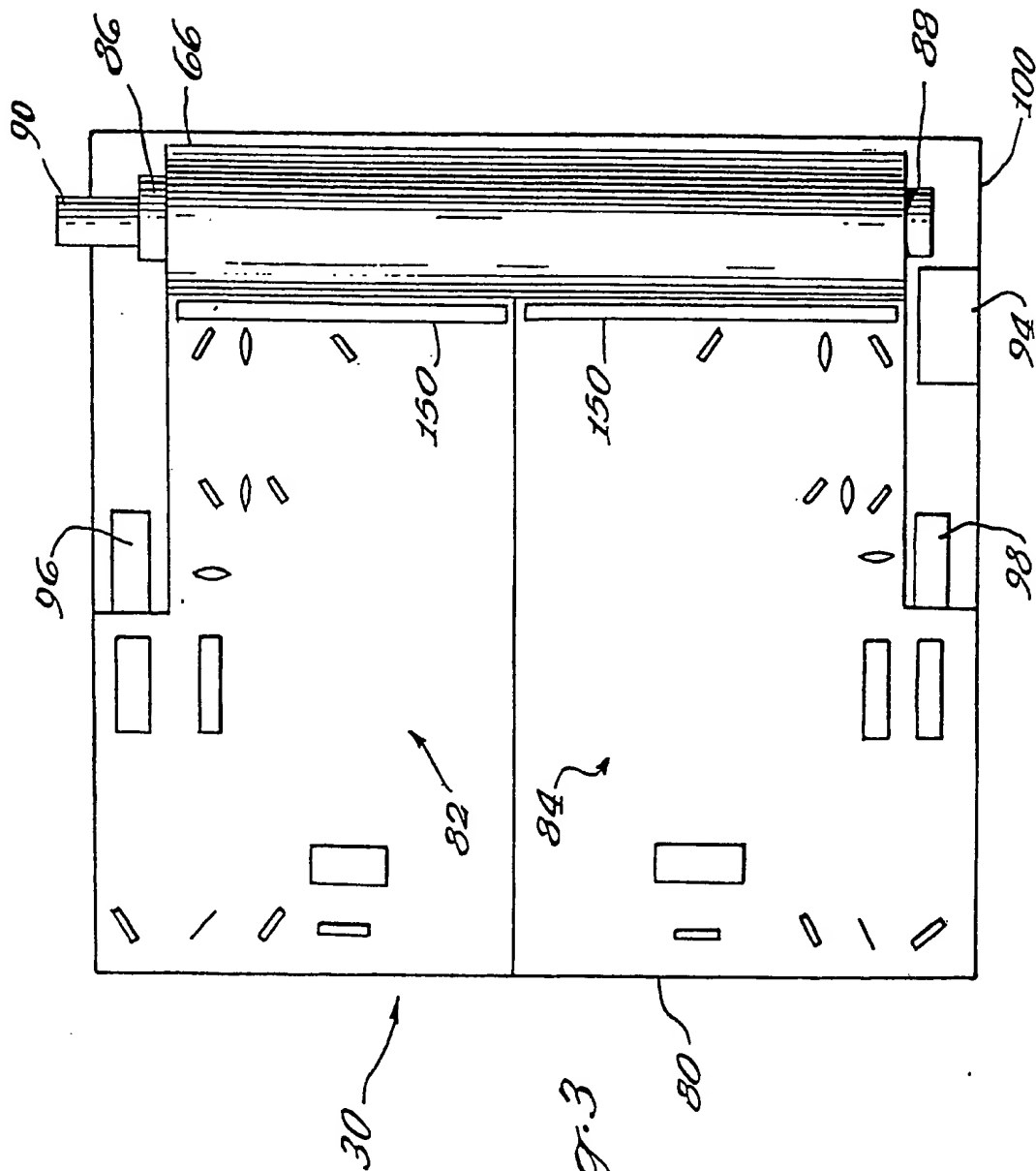


Fig. 1

2/17



3/17



4/17

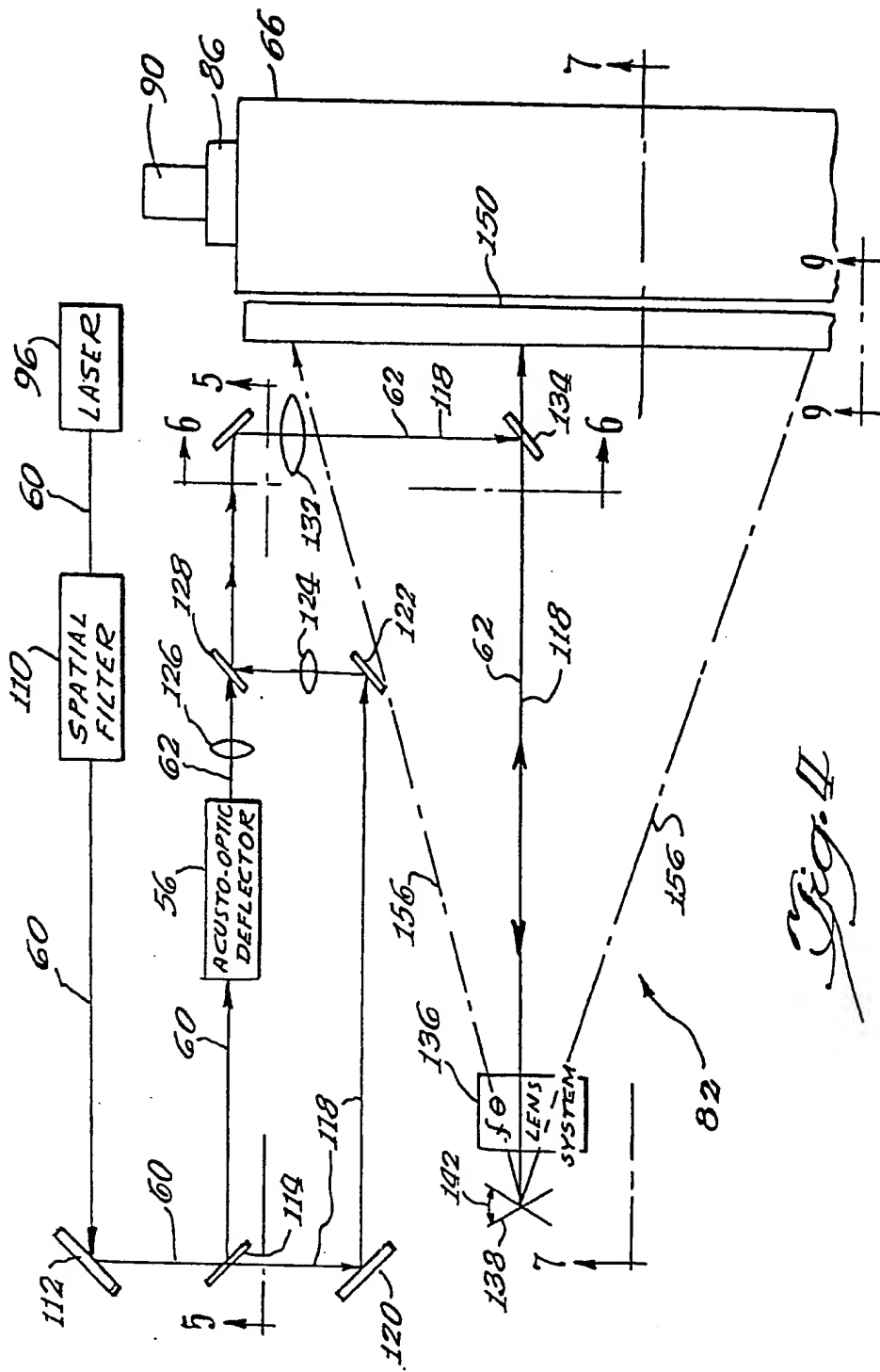
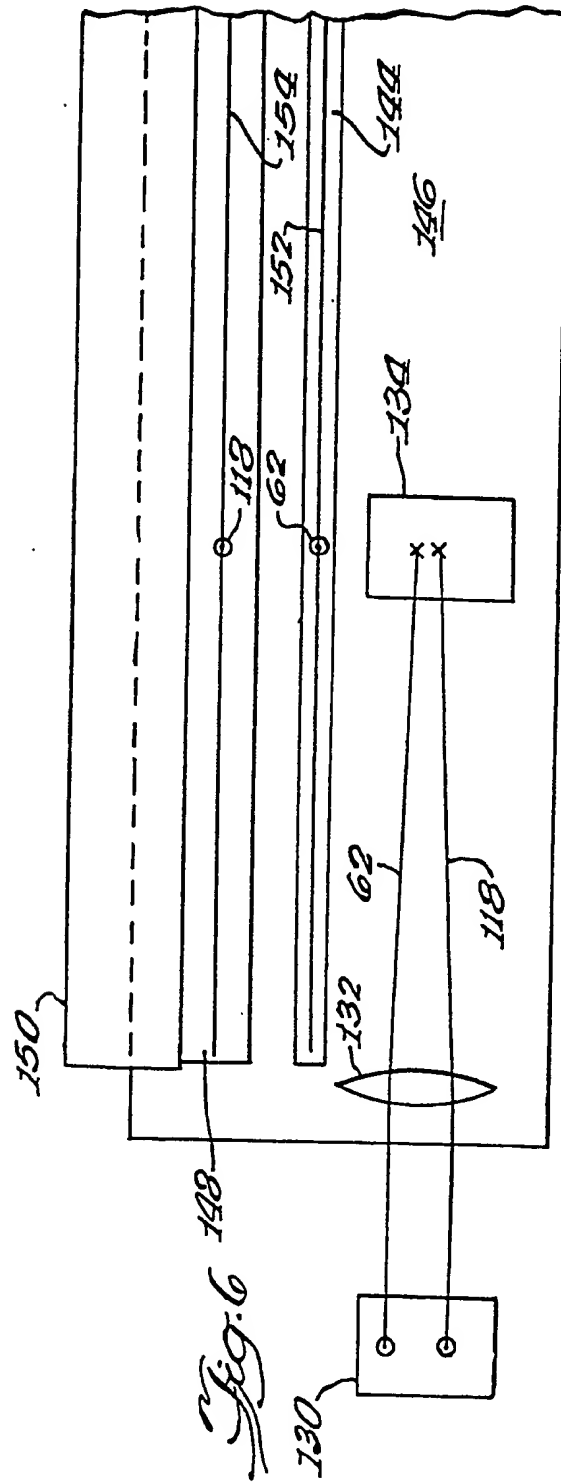
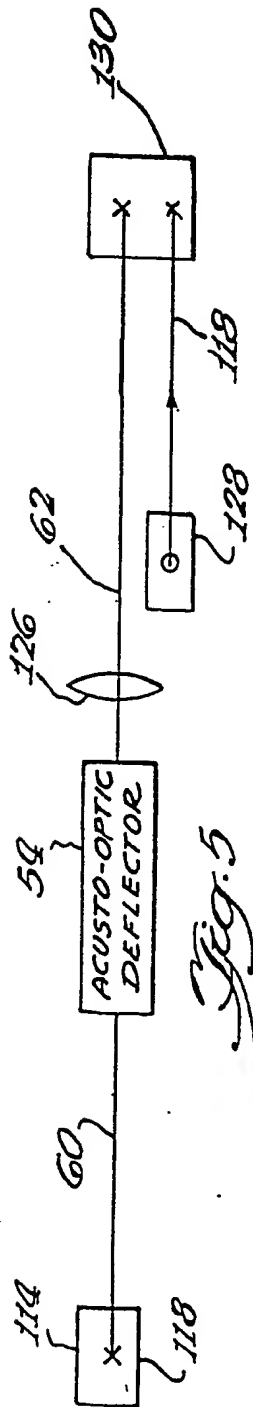
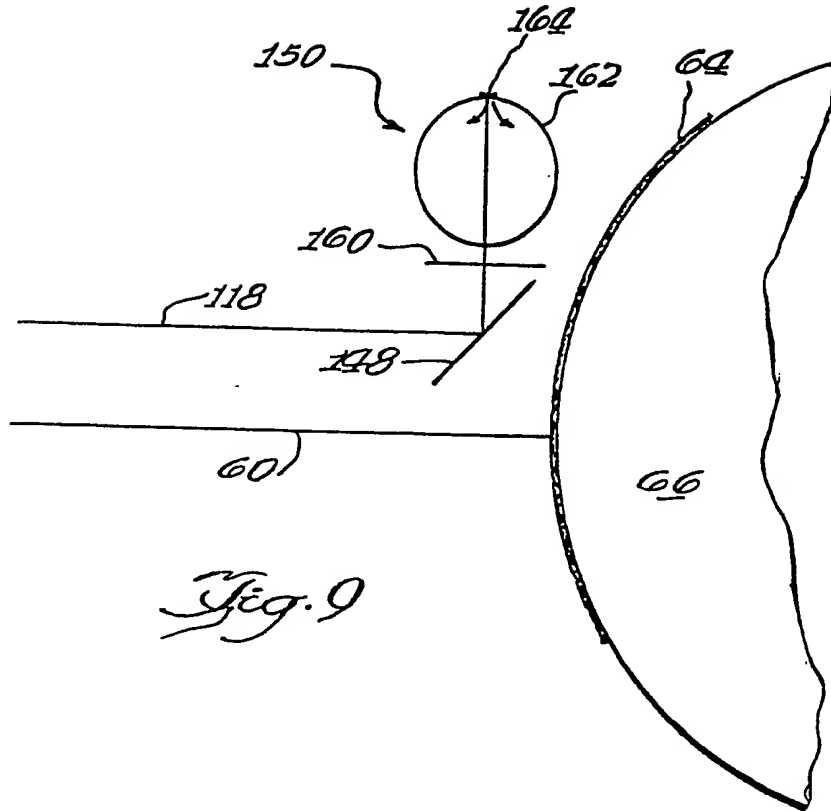
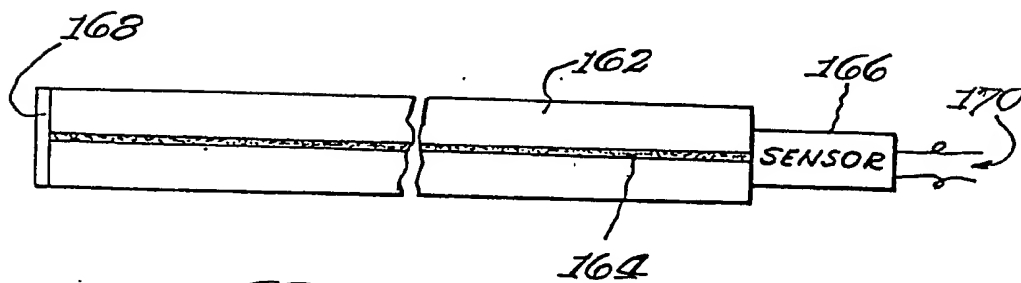


Fig. II

5/17



7/17

*Fig. 9**Fig. 10*

8/17

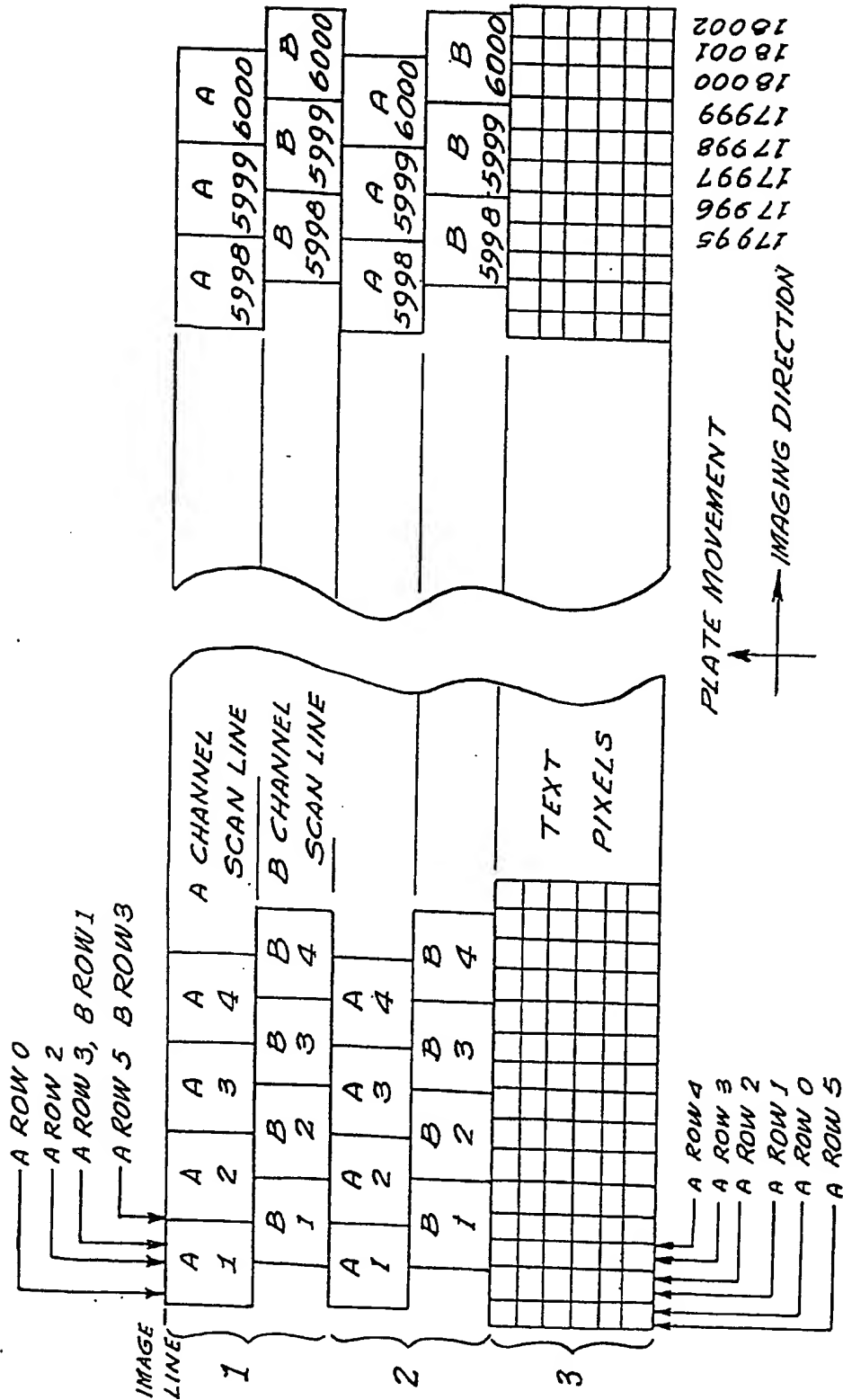
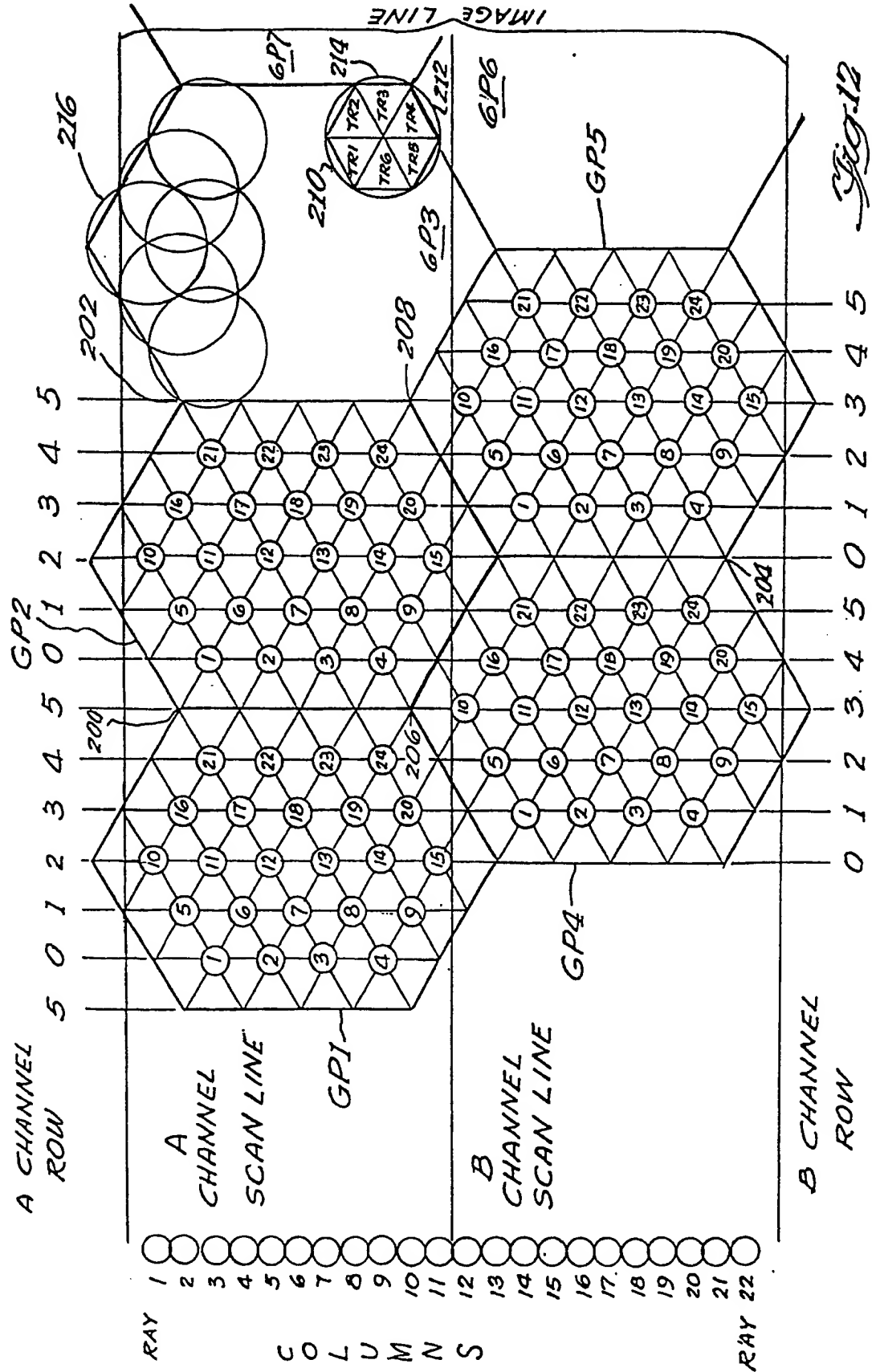
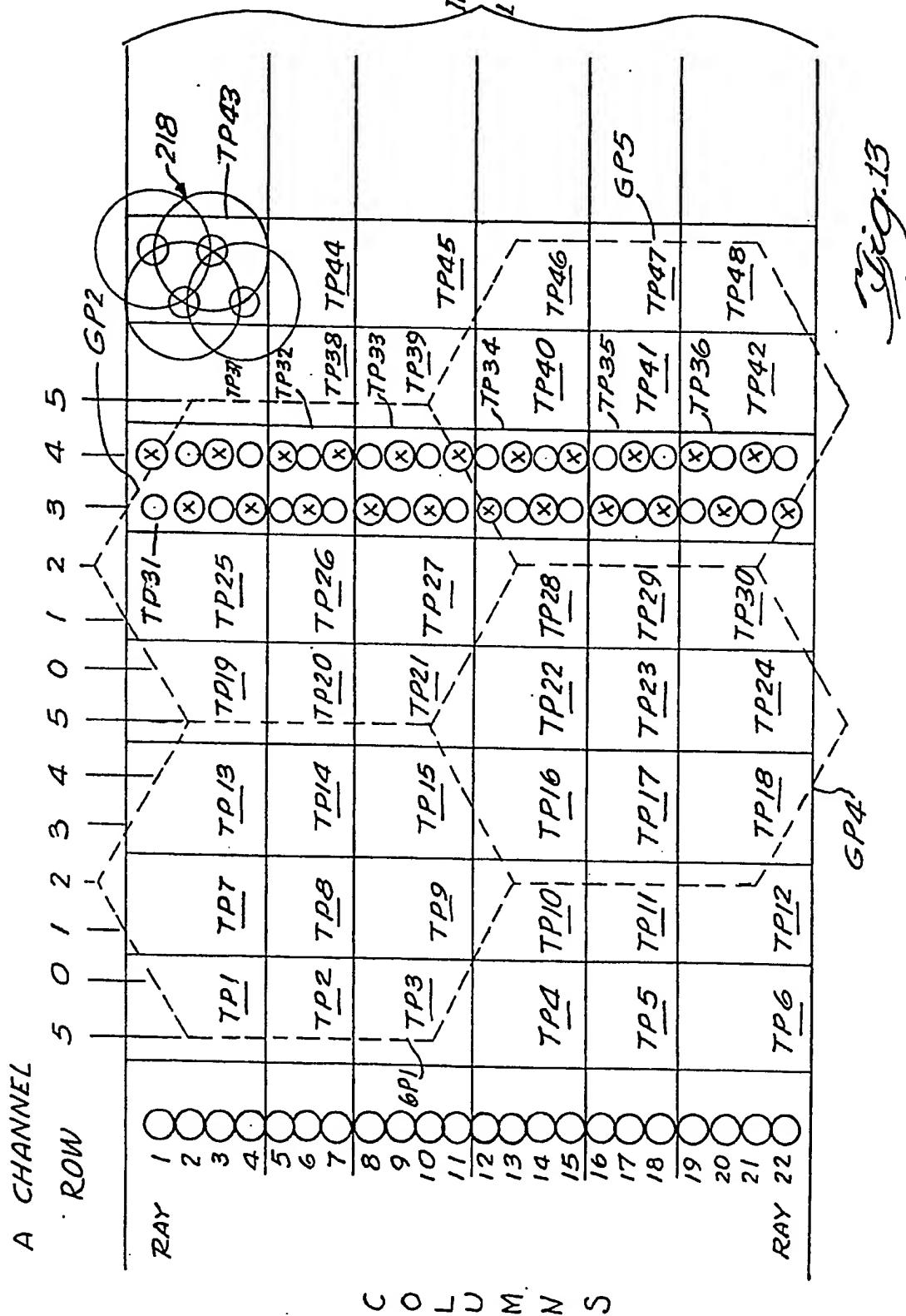


Fig. 11

9/17



10/17

IMAGE
LINE

11/17

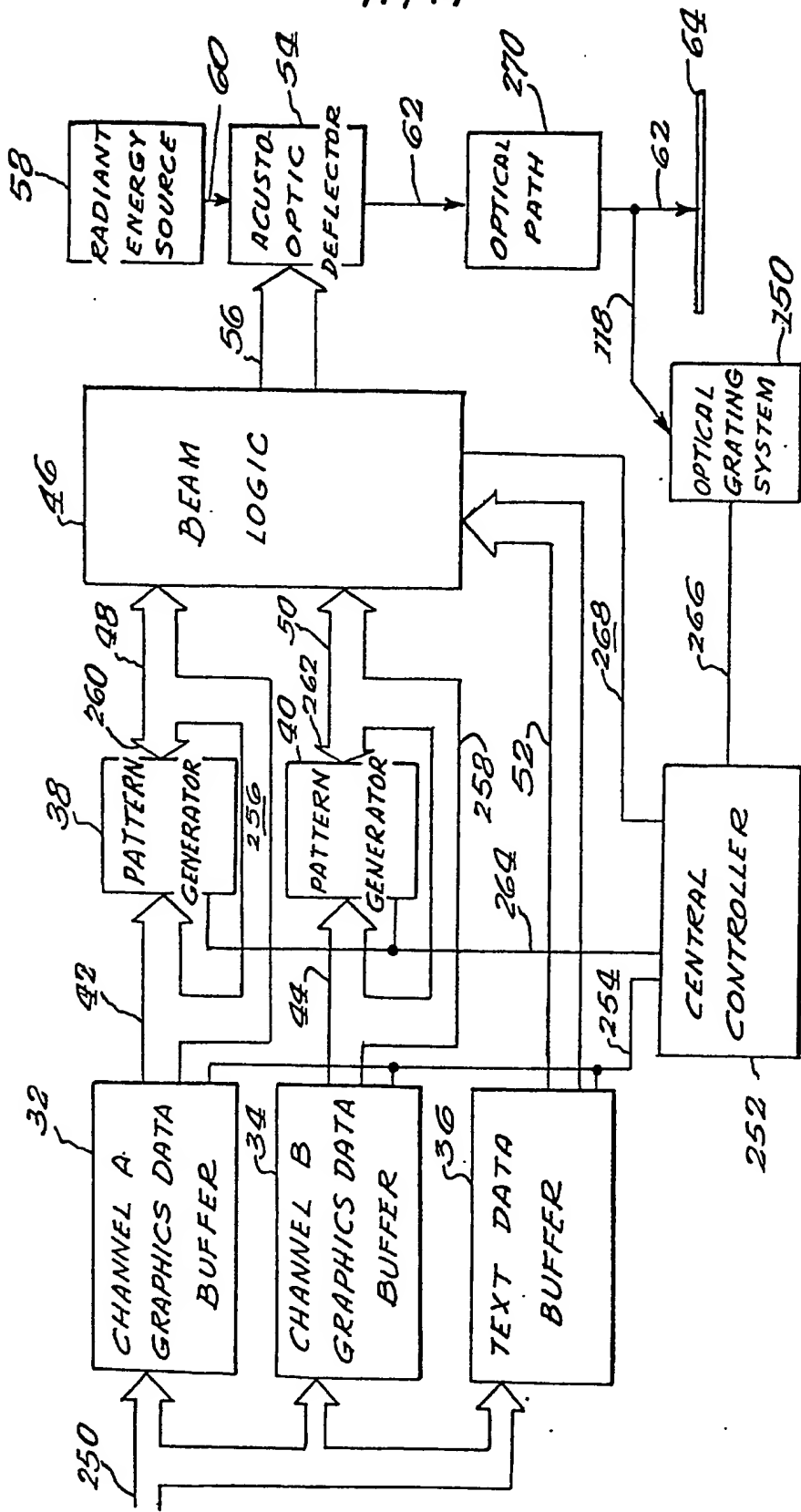
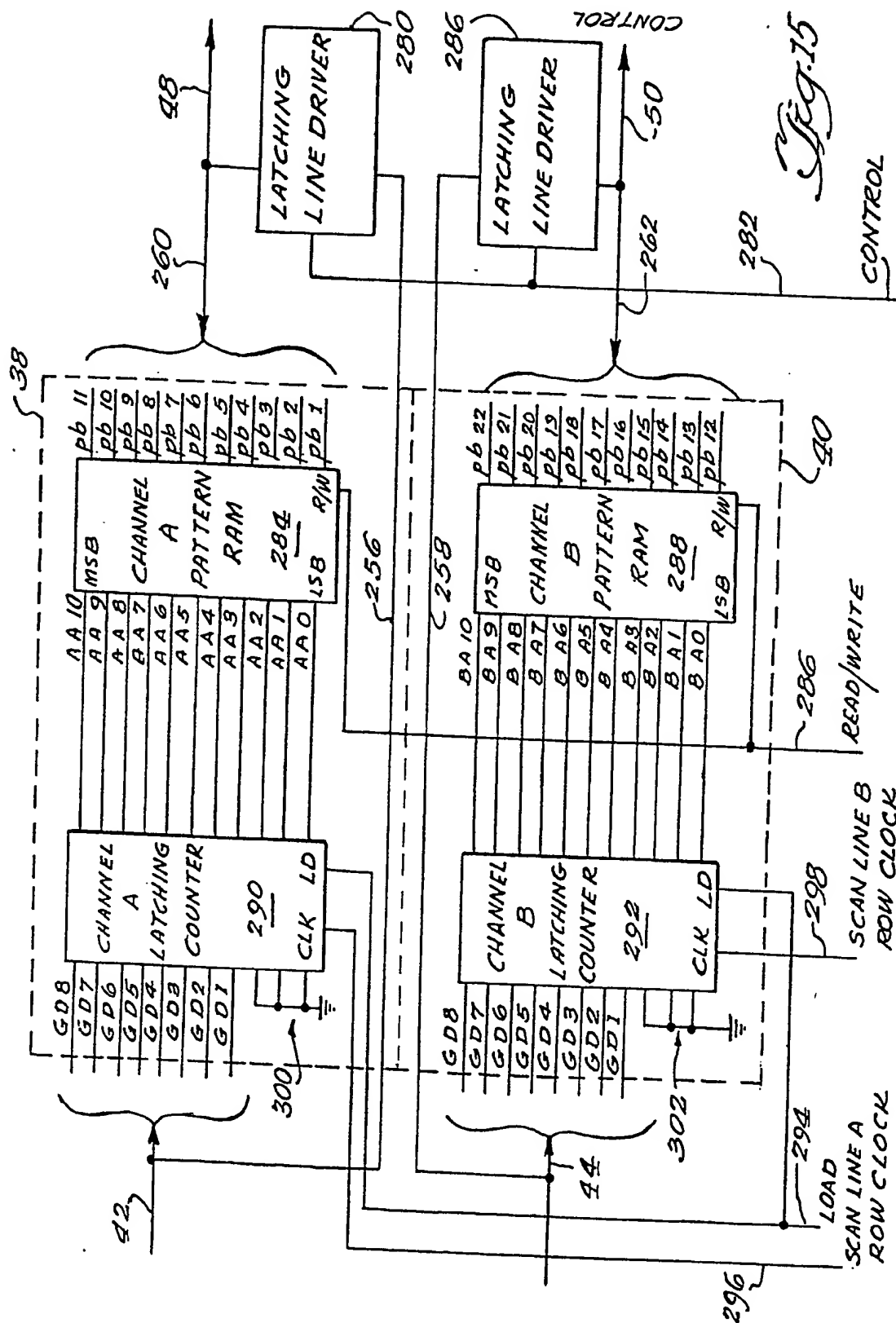
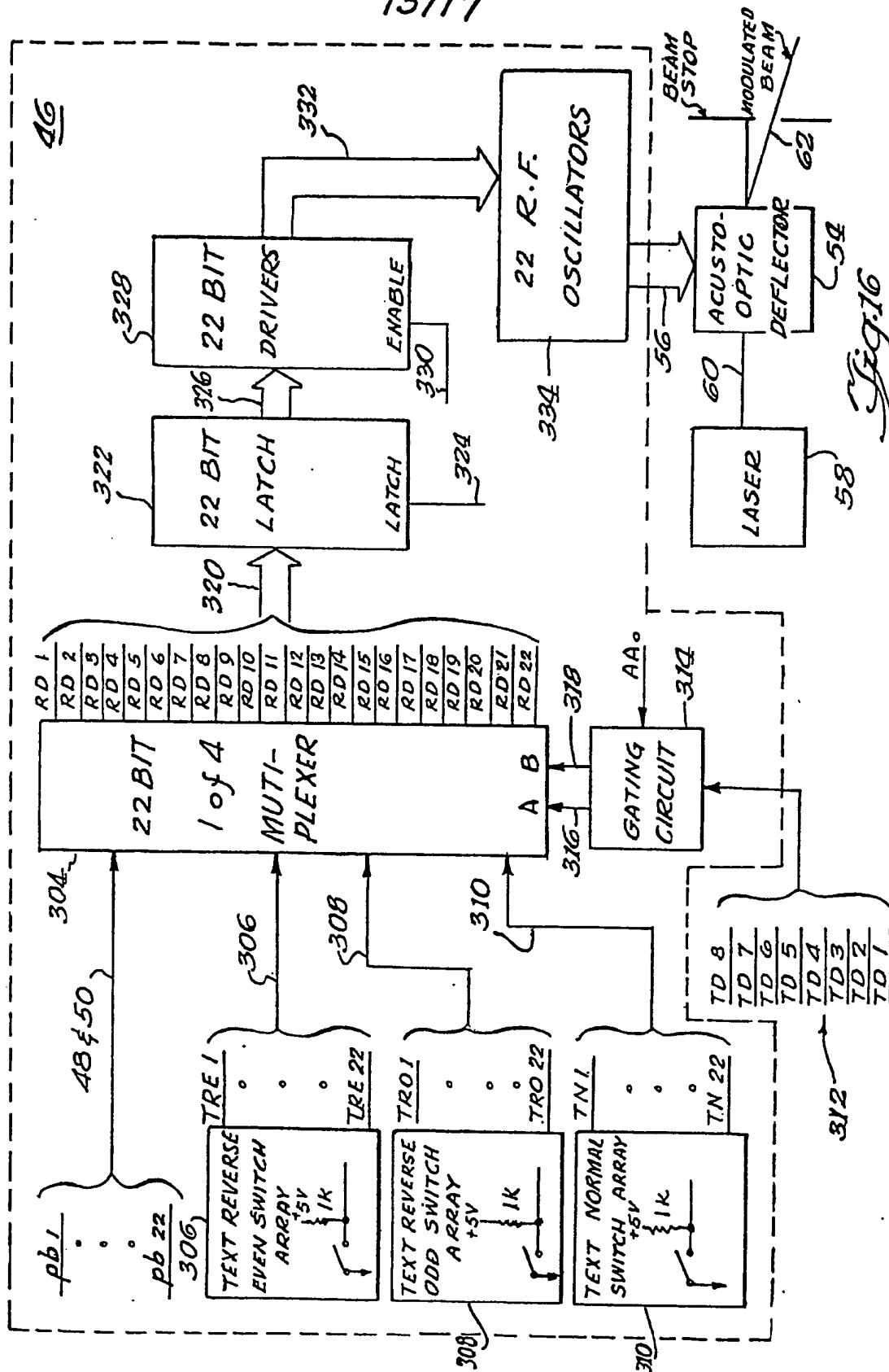


Fig. 14



13/17



15/17

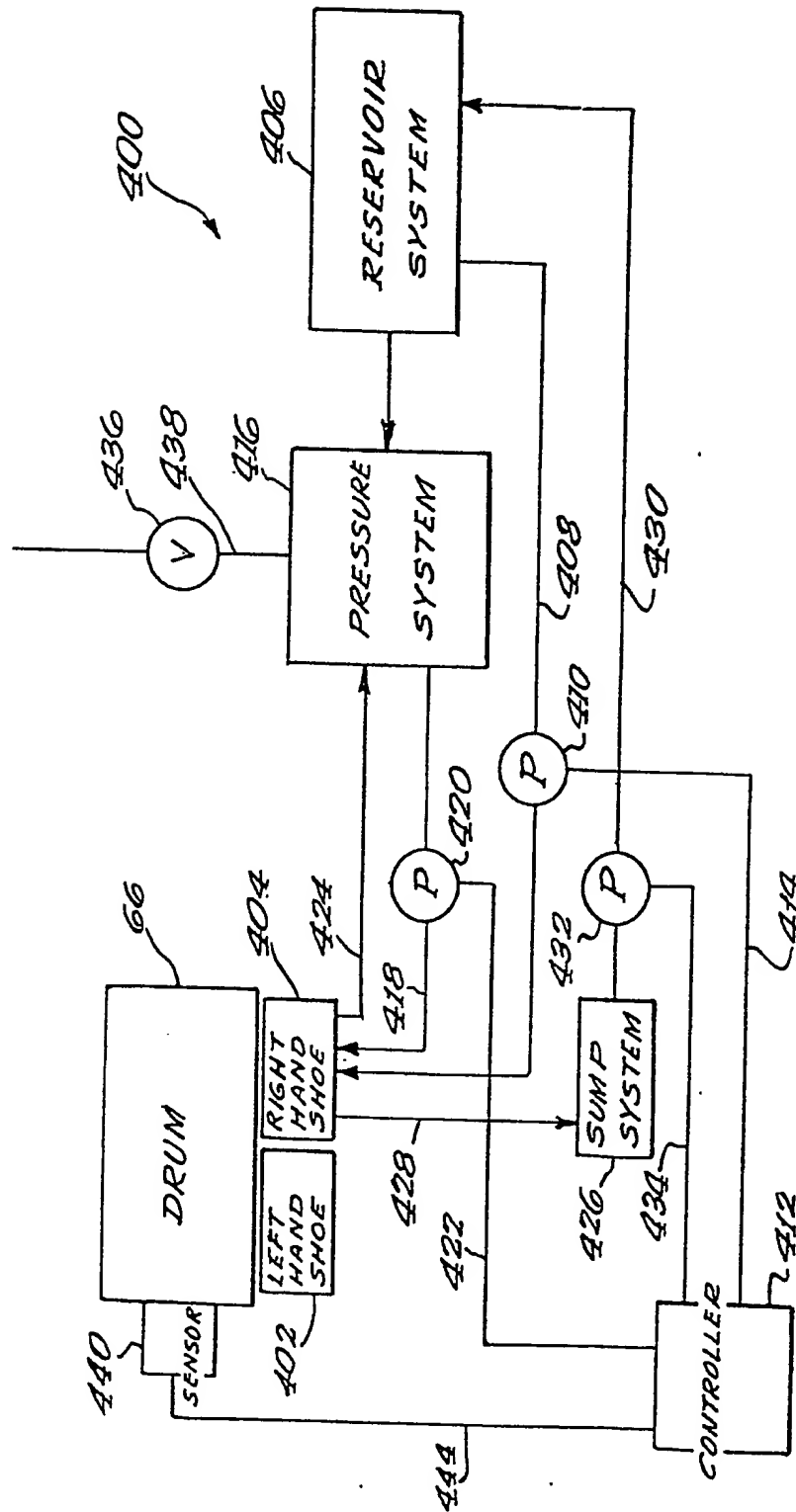
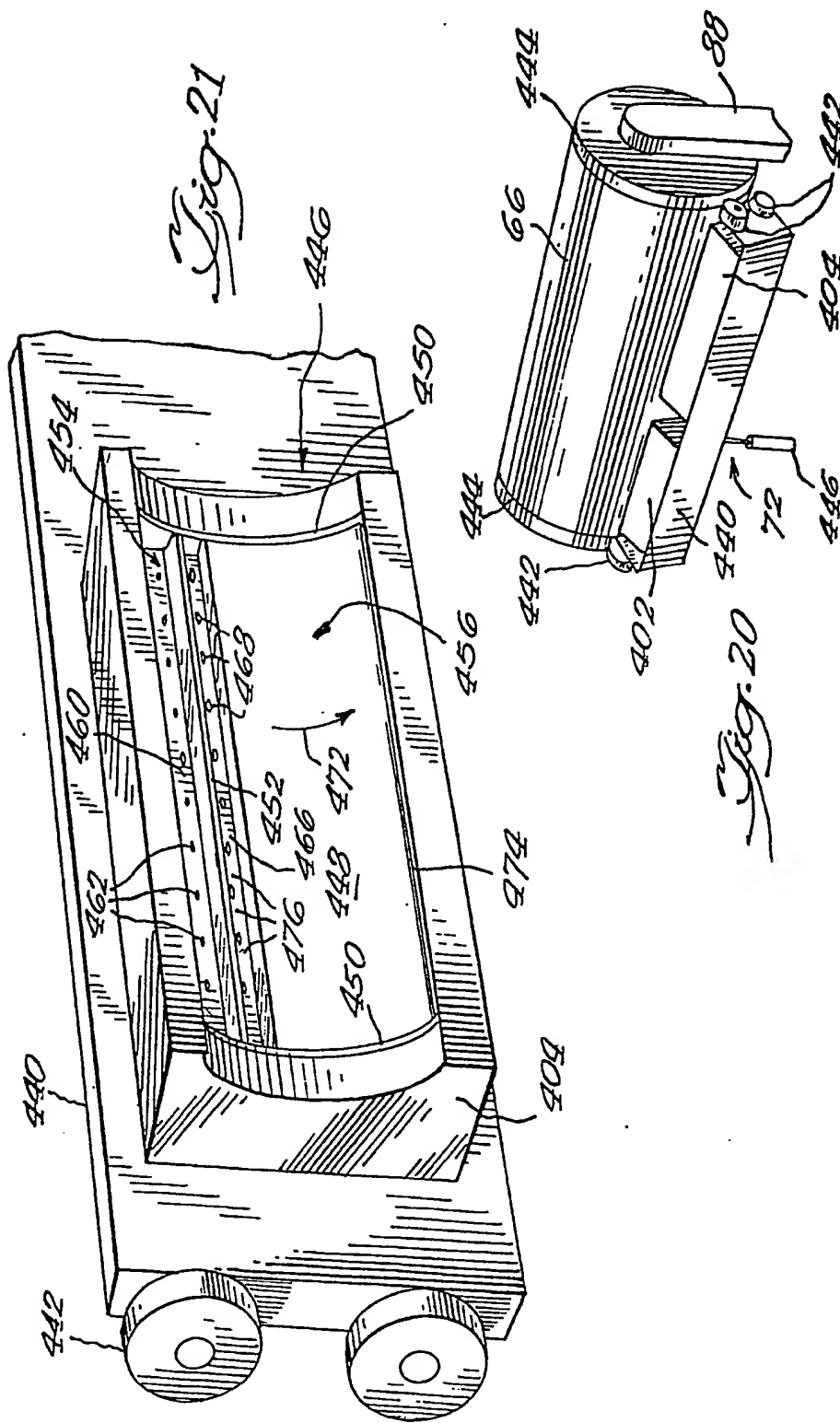


Fig. 10

16/17



17/17

Fig. 22

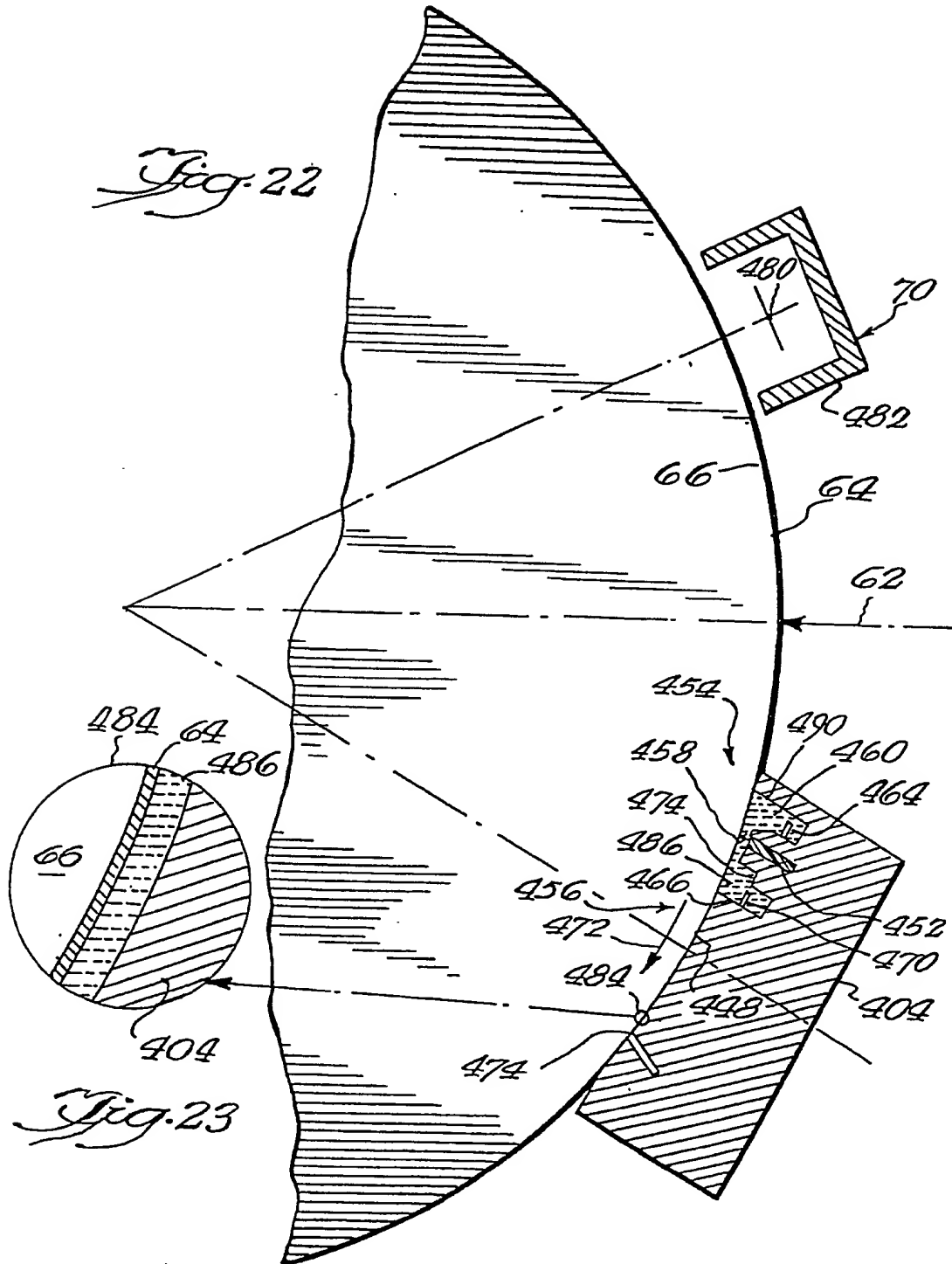


Fig. 23